HEALTH RISK ASSESSMENT ASSOCIATED WITH WOOD DUST EXPOSURE AND RISK MANAGEMENT FOR INCENSE AND JOSS STICK WORKERS, ROI-ET PROVINCE THAILAND

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การประเมินและการจัดการความเสี่ยงสุขภาพจากการสัมผัสฝุ่นไม้ของคนงานทำธูปในชุมชน
จังหวัดร้อยเอ็ด ประเทศไทย

นางแสงโฉม ศิริพานิช

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
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Thesis Title	HEALTH RISK ASSESSMENT ASSOCIATED WITH WOOD DUST EXPOSURE AND RISK MANAGEMENT FOR INCENSE AND JOSS STICK WORKERS, ROI-ET PROVINCE THAILAND
By	Mrs. Sangchom Siripanich
Field of Study	Public Health
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แสงโฉม ศิริพานิช : การประเมินและการจัดการความเสี่ยงสุขภาพจากการสัมผัสฝุ่นไม้ของคนงานทำธูปในชุมชน จังหวัดร้อยเอ็ด ประเทศไทย. (HEALTH RISK ASSESSMENT ASSOCIATED WITH WOOD DUST EXPOSURE AND RISK MANAGEMENT FOR INCENSE AND JOSS STICK WORKERS, ROI-ET PROVINCE THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. วัฒน์สิทธิ์ ศิริวงศ์, อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: ศ. ดร. มาร์ค เกรกอร์ รอบสัน, 135 หน้า.

วัตถุประสงค์: (1) เพื่อประเมินสิ่งแวดล้อมในสถานที่ทำงานและบ่งชี้สิ่งคุกคามสุขภาพในกลุ่มอุตสาหกรรมทำธูปในครัวเรือน (2) เพื่อประเมินความเสี่ยงและผลกระทบต่อสุขภาพในกลุ่มผู้ประกอบอาชีพทำธูป (3) เพื่อเป็นแนวทางในการจัดการลดความเสี่ยงและผลกระทบสุขภาพในกลุ่มผู้ประกอบอาชีพทำธูปในตำบลดงแดง อำเภอจตุรพักตรพิมาน จังหวัดร้อยเอ็ด

รูปแบบและวิธีการศึกษา: การศึกษาแบ่งเป็น 2 ระยะ คือ ระยะแรกเป็นการศึกษาภาคตัดขวาง เพื่อประเมินสิ่งแวดล้อมในสถานที่ทำงานและสิ่งคุกคามสุขภาพ เก็บข้อมูลโดยวิธีการเดินสำรวจและสังเกต บันทึกข้อมูลลงในแบบฟอร์มที่พัฒนาและปรับปรุงจากแบบเดินสำรวจด้านอาชีวอนามัยของแคนาดา และการตรวจวัดประเมินฝุ่นและอนุภาคขนาดเล็กโดยการอ่านผลทันที่ในสถานที่ผลิตธูป โดยวัดในทุกขั้นตอนการผลิต (ผสมฝุ่นขี้เลื้อย การคลุกก้านไม้ไผ่กับขี้เลื้อย การย้อมสีธูป การตาก การฉีดสเปรย์น้ำหอมธูป) การประเมินผลการปนเปื้อนสารเคมี โดยการตรวจวัดปริมาณสารโลหะหนักตกค้างในธูป และสีย้อมที่เหลือจากการผลิต ระยะที่สอง เป็นการศึกษาเพื่อประเมินความเสี่ยงและผลกระทบสุขภาพจากการประกอบอาชีพทำธูป โดยการใช้แบบสอบถามสัมภาษณ์เพื่อประเมินอาการและความเสี่ยงของโรคระบบทางเดินหายใจ ผิวหนัง และอื่น ๆ การตรวจสมรรถภาพปอด และการตรวจวัดการสัมผัสสารตะกั่ว เปรียบเทียบระหว่างกลุ่มคนทำธูปและไม่ได้ทำธูป รวมข้อมูลทั้งสองระยะเพื่อประเมินความเสี่ยงสุขภาพ โดยใช้สถิติเชิงพรรณนา ค่าร้อยละ ค่าเฉลี่ย ค่าความเบี่ยงเบนมาตรฐาน การวัดความเสี่ยง odd ratio, 95% CI, t-test, fisher exact test และ ANOVA

ผลการศึกษา : จากการเดินสำรวจและสังเกตในสถานที่ผลิตธูป พบว่า การทำธูปต้องอาศัยขี้เลื้อยและผงทำธูปเป็นองค์ประกอบหลัก ฝุ่นและสารเคมีเป็นสิ่งคุกคามที่มีโอกาสเป็นอันตรายต่อสุขภาพ จากการตรวจวัดความเข้มข้นของปริมาณฝุ่น พบว่า เกือบทุกขั้นตอนมีปริมาณฝุ่นค่อนข้างสูง โดยเฉพาะในขั้นตอน การคลุกก้านไม้ไผ่กับผงขี้เลื้อยและการห่อธูป ค่าเท่ากับ 0.538±0.26 และ 0.475±0.16 (mg/m3± SD) ตามลำดับ และ จากการตรวจสารโลหะหนักธูป และสีย้อม พบค่าสารโลหะหนักหลายชนิด ได้แก่ ตะกั่ว (Pb),โครเมี่ยม (Cr), แมงกานีส (Mn) และ นิเกิล (Ni) โดยเฉพาะที่อยู่ในธูปที่รอจำหน่าย เท่ากับ 0.95 ± 0.03, 0.89 ± 0.10, 0.87 ± 0.13, 0.99 ± 0.10(mg/kg± SD) ตามลำดับ และ พบว่า คนทำธูปมีการใช้เครื่องป้องกันตนเอง เช่น การสวมผ้าปิดจมูก เพื่อป้องกันฝุ่น เพียงร้อยละ 3.9 เท่านั้น ซึ่งจากการประเมินผลความเสี่ยงต่อสุขภาพ โดยวิธีการสัมภาษณ์ พบว่า คนทำธูปที่อาการหรือความเสี่ยงเกิดได้มากกว่าคนไม่ทำธูป คือ หายใจเสียงหวีด, ระคายเคืองตา คอแห้ง, คัดจมูก น้ำมูกไหล, และระคาย คัน ผิวหนัง (OR = 2.58,2.33, 2.18 และ 2.22 ตามลำดับ) และจากการตรวจวิเคราะห์การสัมผัสสารตะกั่ว เปรียบเทียบทั้งสองกลุ่ม พบว่า ค่าเฉลี่ยทั้งสองกลุ่มแตกต่างกันอย่างมีนัยสำคัญทางสถิติ ($p< 0.005$) แต่อย่างไรก็ตาม การตรวจสมรรถภาพปอดของทั้งสองกลุ่ม ค่าพารามิเตอร์ FVC, FEV1, FEV1 / FVC and FEF25–75 ที่ตรวจวัดได้ไม่มีความแตกต่างกันทางสถิติแต่แนวโน้มค่าจากตรวจสมรรถภาพปอดในกลุ่มคนทำธูปมีค่าน้อยกว่าคนไม่ได้ทำธูป และหากพิจารณาในเฉพาะกลุ่มทำธูป พบว่า ระยะเวลาทำธูปมีผลกับการทำงานของปอด โดยคนที่ทำธูปมานานกว่า 10 ปี ค่า FVC, FEV1, FEV1 / FVC and FEF25–75 มีแนวโน้มลดลง

สรุปผลและอภิปราย: ฝุ่น และสารเคมีที่ใช้ในกระบวนการผลิตธูปเป็นสิ่งคุกคามที่สำคัญ ซึ่งอาจก่อให้เกิดปัญหาสุขภาพที่มีผลต่อระบบทางเดินทางหายใจ ระบบประสาท ผิวหนัง แม้ว่าการตรวจประเมินสมรรถภาพปอดจะไม่บ่งบอกผลกระทบที่ชัดเจน แต่การทำธูปในระยะยาวอาจเกิดผลต่อสุขภาพได้ ดังนั้น การให้ความรู้ และเครื่องมือเพื่อการป้องกันตนเอง รวมทั้งการปรับปรุงสิ่งแวดล้อมในการทำงานเพื่อลดความเสี่ยงและผลกระทบสุขภาพ ควรต้องดำเนินการในอุตสาหกรรมผลิตธูปในครัวเรือนต่อไป

สาขาวิชา สาธารณสุขศาสตร์

ปีการศึกษา 2556

ลายมือชื่อนิสิต ....

ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก ....

ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม ....

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KEYWORDS: HEALTH RISK ASSESSMENT / INCENSE AND JOSS STICK / THAILAND

SANGCHOM SIRIPANICH: HEALTH RISK ASSESSMENT ASSOCIATED WITH WOOD DUST EXPOSURE AND RISK MANAGEMENT FOR INCENSE AND JOSS STICK WORKERS, ROI-ET PROVINCE THAILAND. ADVISOR: ASST. PROF. WATTASIT SIRIWONG, Ph.D., CO-ADVISOR: PROF. MARK GREGORY ROBSON, Ph.D., 135 pp.

Objective: (1)To assess environmental workplace exposure and identification hazards in the incense stick household factory. (2) To evaluate health risk and health effects among incense and joss stick worker (3) To plan for management and reducing health risk and health effect among incense workers in Dong Deang sub district, Roi - et province.

Methods: The study was divided into 2 phrases; the first phrase was cross sectional study by walkthrough survey and observation for environmental workplace assessment. Dust and particle concentration was measured in environmental workplace; chemical concentration assessment was detected in dissolved dyeing and incense products. The second phrase was retrospective cohort study for evaluation health risk and effects comparative between incense workers and non- incense workers. Data collection by questionnaires interviewed, pulmonary function deficit testing by spirometry and blood lead level testing for evaluation of chemical exposure. The descriptive and analytical analysis were used for analysis the study; ANOVA, t-test, and fisher exact analysis for statistic significance (α at 0.05). Odd ratios and 95% confidence internal for coefficients.

Results: Dust and chemical used in the incense making process were the majority hazards as shown by a real time exposure measured dust and small particle concentrations in workplace. The dust (PM10) concentrations were high in all the production process especially in stage of rolling and shaking wood powders onto the sticks and packing and wrapping were 0.538 ± 0.27 and 0.475±0.16 mg/m3±SD. Heavy metals which were detected in incense products such as Lead (Pb), Chromium (Cr), Manganese (Mn), and Nickel (Ni) were 0.95 ± 0.03, 0.89±0.10, and 0.87 ± 0.13, 0.99±0.10 (mg/L±SD), respectively. The unadjusted OR for wheezing sound, block nose and nose irritation, irritation eyes, and skin dermatitis, skin itchy were 2.58,2.18 2.33 and 2.22, respectively and the significant excess risk of respiratory illness in incense workers than non incense workers. The average mean of blood lead level among incense workers was 4.76±1.70 μg/dL and non- incense workers was 3.54±1.05 μg/dL. These values showed that the difference in blood lead concentrations was significantly higher in the incense workers than non- incensive workers ($p>0.05$). However, the pulmonary function testing by parameter value, FVC, FEV1, FEV1 / FVC and FEF25–75 were not statistically significant difference between groups. But there were lower in incense workers than controls groups and may due to duration of work.

Discussion: Dust and chemicals were major threats in incense stick making process may effect to respiratory system, skin irritation, neurological symptoms. Although the health effects assessment may not be clearly associated with pulmonary function testing and respiratory symptoms between incense workers and non- incense workers, the duration of work and are significant to health effects, therefore knowledge for reducing the health risk, personal protection equipment (PPE) using and environmental workplace management should be developed in small household factory.

Field of Study: Public Health	Student's Signature ....
Academic Year: 2013	Advisor's Signature ....
	Co-Advisor's Signature ....

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CHAPTER I
INTRODUCTION

1.1 Background & Rationale

After the economic crisis started in Thailand in 1997, the situation leaded several changes in economic status in country and affected employment in large scale enterprises. The workers in sort of large industrial were decreased and were out of work. The small and medium scale enterprises (SMEs) have increased from government policy to supporting funds and resolving effects of the economic crisis. The total number of Thai SMEs in 2006 was 2,274,525 and, employment in SMEs was 8,863,334, their employment classified by sector concentrated most in the production sector for 45.3%, followed by 30.0% in service sector, and 24.7% in trade sector. Bangkok and vicinity had the highest employment followed by the northeastern region, the northern region, the eastern region, and the southern, central and western regions respectively. (The2nd SMEs Promotion Action Plan, 2007-2011, OSMEP). The small and medium factories were widely distributed according to communities and villages after the policy development. Many products were produced from community and household for example; dry fruits, silk dying, sewing garment, electronic components, packaging, textiles, shoe-making, furniture, and incense and joss stick etc. However, the distribution of small factories into communities may contribute to occupational and environmental health problems in the future. So it should be awareness and critical to this problem.

The World Bank reported in 2005, that the informal sector may account for up to 40 to 60 percent of urban employment in Asia, with woman and children constituting a major proportion of workers in the informal economy. (Charmes, 2001). The growing of informal workers and household factory increase family income and contribute to national income, but they also encounter health risk from occupational health hazard in process of production. Generally, the health problem of home workers are caused by expose to health hazard, inappropriate working condition, and prolong working hours.(ILO,2001) There are resulting in inadequate safety and health standards, environmental degradation and a lack of basic protection for workers. This result will be changed of community health status.

The national statistical office of Thailand (NSO.) reported an economically active population of 63.5 million people. There were 68 percent in urban areas and 32 percent in rural zones. The estimated of workers were 37.1 million. These workers were formal worker 13.8 million (37.3%) and informal workers 23.3 million. (62.7%) (NSO., Thailand, 2009). Although the increasing number of informal and household workers, the planning for prevention and protection have not seen and managed. The health and welfare protection of home workers is a challenge to integrate an approach to the health promotion.

The magnitude of mortality and morbidity rate of household workers are difficult to establish. Most home workers activities are unrecorded in the official statistics. Available data are scattered and old - fashioned. There is scarce information on occupational diseases and accidents arising from hazardous working conditions which could be used for identification of the priority areas of prevention. A previous study showed that most home - workers who had an average incomes 4,234 baht and average age 35.2 years old, (female 51.2 % and male 48.8 %) had a respiratory tract disease 43.6 %. The great majority of home workers 88.5 percent had never checked their physical within one year and of 80.4 percent had not accessed to health service when illness by 30 baht per visited. (Supachai, 2005)

The situation on occupational accidents in informal workers is increasing in each year. The result showed that occupational injuries have increased from 12.7 to 15.7 percent during 2005 to 2007 (NSO. 2007). The majority of home-workers have been living and working in poor areas. Many factories are operated in their household. Vulnerability to diseases and poor health results from a combination of undesirable living and working condition. For occupational injuries, the trend of occupational diseases is likely increasing. According to some ad hoc surveys carried out by ILO in Philippines, Nigeria, Senegal and Tanzania, most prevalent problem were lack of ventilation, poor lighting, excessive heat, poor housekeeping, inadequate work space and working tool, lacking of protection equipment, exposure to hazardous chemical and dust and long hours of work. The most prevalent health impairment was muscular-skeletal disorder and low back pain, allergic reactions and respiratory disorders. (Mehrotra et al., 2006 ; Biggeri et al., 2006)

In Thailand, the data are mostly recorded on occupational accidents in home - workers, only few data recorded on occupational diseases such as low back pain, respiratory diseases, allergic dermatitis, etc. The lack of information on occupational accident and diseases and health risk assessment are arising from hazardous working condition which could be used for identification problem prevention. Many products are manufacturing in community. The incenses and joss stick is one of the manufactures in community as increasing an extra family income. The process of incense is straight ward making process. Incense and joss stick is generally made from a combination of fragrant gums, resins, woods, etc. There are several sorts of incenses including sticks, joss sticks, cones, coils, powders, rope, rocks and smudge bundle. The main difference between sticks and joss sticks are the formal has a slender bamboo base. The typical composition of incense sticks consists of herbal and wood powder, fragrance material, adhesive powder, and bamboo stick. Dust is the primary raw material and there are no safety hazards to workers. During making, incense makers have not protective clothes, masks or gloves. They work in an atmosphere full of fine dense dust of incense powder and have not receive health checks during their working.

Many workers in several factory such as furniture making, sawmills, cabinet makers, paper mills and incense maker may be exposed to high levels of wood dust. The American Conference of Government Industrial Hygienist (ACGIH.) recognizes wood dust as a confirmed human carcinogen and recommends a threshold limit value (TLV) of 1 milligram per cubic meter (mg/m^3) for hardwoods and 5 mg/m^3 for softwoods, as TWAs for normal 8-hours workday and a 40 - hour workweek and a short - term exposure limit (STEL) of 10 mg/m^3 for softwoods. (ACGIH. 1994)

Exposure to wood dust may cause external and internal health problems. The adverse health effects associated with wood dust exposure include dermatitis, allergic and non allergic respiratory effects, asthma and cancer. The National Institute for occupational Safety and Health (NIOSH.) considers both hardwood and softwoods dust to be carcinogenic to humans. The three types of cancers associated with wood dust exposure are nasal and sinus cavity cancer, lung and other cancers. (Thomas, 2006)

The incense stick makers may be have health risks such as respiratory diseases, skin disease, nasal cancers from expose to toxics woods dust, resins, and chemical. The recent survey conducted by the Technical Science and Labor Safety Sub-institute in Vietnam to survey in incense villages found the density of incense dust was 15 mg/cubic meter and the concentration of toxic gases was 25 mg /cubic meter and environmental health survey in 100 workers at incense making village, which found that incense making was one of the most toxic crafts and the makers suffered from serious diseases in their lung, ears, throats, noses, skin and women had many gynecological problems.(Vietnam Net Bridge, 2007)

picture 1 Incense worker during work.

The survey wood dust exposure levels and pulmonary effects among joss stick workers in China. Greater dust concentration were measured by six-stage cascade impacts and observed in work areas where joss sticks were produced and incense was mixed than in other work areas. The prevalence of respiratory symptoms for exposed workers was not significant higher than controls. (Saou-Hsing and June-Lung, 1996.) However, there are few epidemiology studies of health hazards associated with incense stick workers in other countries.

Many provinces in Thailand are making incense in village such as Ayutthaya, Chieng Mai, Uthaithani, Singhburi, Phatumtani, Roi-et, etc. The largest manual incense production unit is *Dong*

Deang sub-district, in Roi-et province. There are about 7,800 people and 2,182 households and around 115 households are making incense and joss stick. And some household have done more than 10 years. The health status reviewed find the trend of respiratory diseases in community is increasing every year from 745 to 3,512 cases in *Ban Dong Deang* sub-district during 2004 - 2008, that is possible, may be caused arising from exposure wood dust during incense making. (Data survey, 2009)

The evaluation environmental workplace in household factory and health risk assessment associated with wood dust and chemical exposure among incense workers will be identified occupational health risks problem for reducing the health risk and management the environmental workplace. The results and knowledge from this study will use to raising awareness among incense workers and family for protection their health during work in household factory. Therefore, the research to health risk assessment associated with wood dust and chemical exposure and risk management for incense and joss stick workers, Roe-et province, Thailand was then conducted.

1.2 Research Question:

1. What is the magnitude of hazard and health risk effects among incense and joss stick workers?
2. How can be reducing health risk effects among incense and joss sticks workers

1.3 Objective of the study:

The objectives of this study are therefore as following:

1. To assess environmental workplace exposure and identification hazards in the incense stick household factory.
2. To evaluate health risk effects of incense and joss stick worker.
3. To plan for management and reducing health risk and health effect among incense workers.

1.4 Hypothesis

H0 : Health risk and health effects (respiratory symptom, Pulmonary function value, Chemical exposure) among incense workers are not difference from non -incense workers

H1 : Health risk and health effects (respiratory symptom, Pulmonary function value, Chemical exposure) among incense workers are difference from non -incense workers

1.5 Scope of the study

The study was conducted to assessed environmental workplace exposure and evaluated health risk and health effects associate with wood dust and chemical exposure among incense and joss stick maker in small household factory in the village at Roi-et province. The study was performed by the step of environmental exposure assessment and health risk assessment and the data were collected from 2011-2012.

The study was divided into 2 phrases; the first phrase was cross sectional study by walkthrough survey and observation for environmental workplace assessment. The second phrase was retrospective cohort study for evaluation health risk and health effect comparative between incense workers and non- incense workers. The results of this study will use for planning to risk management. Since the time and funds limitation, the step of risk management will be not done in this study.

1.6. Definition of Term

1.6.1. Risk assessment:

The process of analysis and characterizing, information about a risk to identify the hazard and vulnerabilities of potential adverse health effects as resulting from human exposure to hazardous agent or situation. (Risk assessment provides "INFORMATION" on potential health or ecological risks) EPA, (1994). The four steps are hazard identification, dose-response assessment, exposure assessment and risk characteristic (U.S Presidential Congressional Commission on Risk Assessment and Risk Management, 1997).

1.6.2. Exposure assessment:

The process of determining the extent to which humans, animals, or the other life form are exposed to hazardous agent. Exposure could be measured in terms of concentration of agent or of duration of frequency of the agent's presence in the environment. (EPA, 1994)

The exposure assessment in the study is the way to measurement the environmental exposure in workplace and occupational health assessment among incense and joss stick workers.

1.6.3. Risk management:

The process of integration of result of risk assessment with social, economic, political, regulation and other information to develop program for risk reduction which evaluates how to protect public health? (Risk management is the "ACTION" taken based on consideration of that and other information). (EPA, 1994)

1.6.4 Wood dust:

Wood dust in this study refers to the dust from incense and joss stick manufacturing process. There are the main raw materials for incense and joss stick productions. They may be derived from several trees and consists of tiny particles of wood. It is varies in particle size from less than a micron to very large particle.

1.6.5. Health risk:

The risk factors from incense and joss sticks making process may be have effected to health such as the risk as related to respiratory illness (cough, wheeze, nose block, nose irritation, etc.), asthma, pulmonary capacity defect, cancer nasal and skin irritation.

1.6.6 Incense and Joss stick:

The product was used for prayers and rituals to try to manifest the gods can be used to enhance the smell of a room, or to light fire crackers. They are made by mixed wood powder and any saw dust with various additives. Different form of incense is cone coil and stick.

1.6.7 Incense and joss stick workers:

Refers to the person both male and female who has been making incense and joss stick in household factory in the villages.

CHAPTER II
LITERATURE REVIEW

2.1. The Mechanics of Occupational Risk Assessment

Risk assessment is the process of identifying the hazard at hand and attempting in some manner to bind or to quantify its level of potential harm under a prescribed set of conditions. There are very important as form an integral part of a good occupational health and safety management plan. To create awareness of hazards and risks, identify who may be at risk such as employees, cleaners, visitors, contractors, the public, etc. Risk assessment determine to control measures and more should be done, prevent injuries or illnesses when done at the design or planning stage, and prioritize hazards and control measures. The aim of the risk assessment process is to remove a hazard or reduce the level of its risk by adding precautions or control measures (Rantanen 1981, Karkoszka and Szewieczek 2007).

The process of risk assessment requires a factual base to define the likelihood of adverse health effects of workplace-associated injuries and exposures, and it attempts to balance scientific knowledge with concerns of staff, investigators, administration, and the public at large. It involves a systematic approach to the identification and characterization of physical, chemical, and biologic hazards to individuals and populations in their environment. The consequences of such hazards can include severe illness or injury, an irreversible health consequence, an unfamiliar disease, and an undesirable situation that might have been avoided by use of an alternative approach or technology. Risk assessments typically require that attention be given first to the most important hazards, that is, the ones that can result in the worst health-related outcomes (Van Leeuwen and Vermeire 2007).

Most health, environmental, and even technological risk assessments have been largely consistent with the basic human health risk assessment paradigm put forth by the National Academy of Sciences’ National Research Council since the early 1980s. The paradigm describes a four-step process for analyzing data, drawing inferences from all available related information and then summarizing the implications in a risk characterization that others, including risk managers and the public, can easily follow and understand" for each step, the relevant and scientifically reliable information is evaluated. In addition, the related uncertainties and science policy choices are describes. The four steps described by the NRC are (1) hazard identification, (2) does-response assessment, (3) exposure assessment, and (4) risk characterization. This paradigm has evolved somewhat to recognize that the first step in any risk assessment involves problem formulation, to account for the interactive nature of these steps, and to broaden their application beyond health risk assessment" for instance, in ecological risk assessment, hazard identification has been replaced by stressor identification, and dose-response assessment has changed to analysis of effects to account for the need to broaden the concept of *dose* in the ecological setting.(NRC, 1980; .CCOHS., 2009)

The most recent contribution to the field of health-risk assessment is the 1997 report of the U.S. Presidential/Congressional Commission on Risk Assessment and Risk Management. The Commission's *Framework for Environmental Health Risk Management* is designed to help all types of risk managers including government officials, private-sector businesses, and individual members of the public make good risk-management decisions when dealing with any type of environmental health risk. The framework is general enough to work in a wide variety of situations, with the level and effort invested being scaled to the importance of the problem, the potential severity and economic impact of the risk, the level of controversy surrounding the risk, and resource constraints. The framework is intended primarily for risk decisions related to setting standards, controlling pollution, protecting health, and cleaning up the environment (Rantanen 2005, Van Leeuwen and Vermeire 2007).

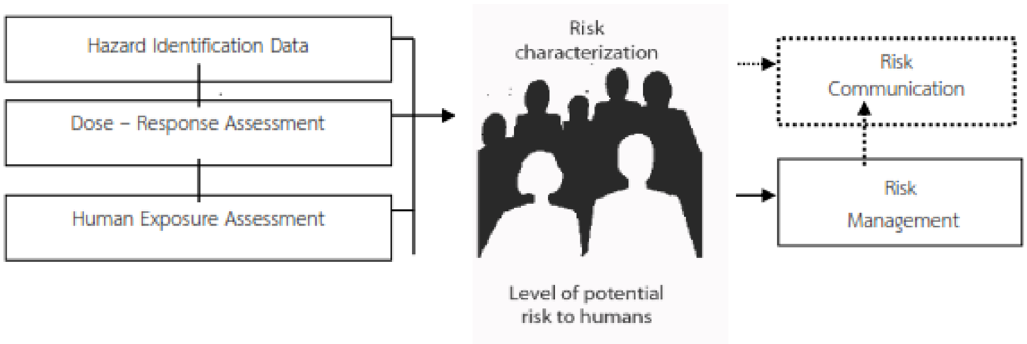


Figure 1 The steps of risk assessment

2.1.1 Hazard Identification:

As the name would suggest, hazard identification is the qualitative association of an activity, location, or pollutant with a hazard. Historically, much of the knowledge that we have on the health effects of certain activities, or that are associated with exposure to environmental contaminants, comes from the occupational setting, since in these settings hazards are abundant. For example, exposures experienced by uranium mine workers has led to a better understanding of the effect of radiation exposure in the general population. Similarly, repetitive strain injuries were first noticed in manufacturing settings, where repeated motion is common. Later, it was noticed in office workers and in the general community. However, it is unlikely that study of non-occupationally exposed in workplace settings. Exposures are generally greater, and for longer duration, making the hazard more readily identifiable in the occupation exposed. (Mark Robson, 2007)

2.1.2 Occupational Exposure Assessment:

Industrial hygiene focuses on the exposures experienced by individuals who work in industrial or occupational settings and may be viewed as a branch of the larger science of exposure assessment. Some definitions are needed to start. These include the concentration of pollutant in an environmental medium, the exposure experienced by an individual, and the dose received by the individual.

2.1.2.1 Concentration, exposure, and dose differentiated.

An important distinction to be made is between the related concepts of concentration, exposure, and dose. The concentration in the tank is relatively simple to understand: it is the saturation vapor pressure of the organic solvent. It can be readily measured using appropriate instrumentation or estimated from the physical and chemical properties of the solvent. This is the concentration that the worker experiences in the enclosed space. Exposure, defined as the amount of hazardous substance delivered to somebody boundary, can come from one of three different routes: inhalation, for which the lung epithelium is the boundary of interest; ingestion, for which the gut epithelium is the boundary of interest; and body-surface contact, for which a body surface, usually the skin, is the boundary of interest. (Robson, 2007)

2.1.2.2 Pathways.

The specific ways the pollutant moves through the environment can be many and varied and should be distinguished from routes of exposure. Let us develop a simple example to distinguish these two concepts better. One may be exposure to sulfur dioxide in various ways, the majority of which lead to exposure through the inhalation route. One particular pathway is the generation of sulfur dioxide through the combustion of sulfur-containing coal, followed by the concomitant release of this gas from the combustion facility, and advection and dispersion in the air. An alternative pathway in an industrial setting might arrive from the use of sulfurous acid in a manufacturing process with the concomitant release of sulfur dioxide at an individual workstation. The worker at his workstation is then exposed directly to sulfur dioxide via the inhalation route. These two pathways differ substantially and would require entirely different control strategies to reduce exposure.

At this point the determination of exposure requires us to gather much more information about the scenario. In an occupational setting such as the one described, the worker should be provided with a respirator that supplies air from outside the tank, as it would be must too dangerous to send an individual into such an enclosed space without such a device. For a saturated vapor in an enclosed tank, the primary concern would be inhalation exposure. If the respirator was fitted perfectly and functioning properly, the worker's actual exposure would be close to zero. However, respirators may be used improperly or not at all, resulting in exposure greater than that expected under this ideal scenario. However, if we presuppose that no other personal protective equipment was required, the worker would still receive an exposure through skin; thus dermal exposure may be an important route and potentially could result in health effects. We must be careful to consider all potential routes and attempt to identify all pathways of exposure. (Robson, 2007; CCOHS. 2009)

2.1.2.3 Magnitude, frequency and exposure duration.

It is also important in understanding exposure to look at the time course of the exposure, sometimes referred to as the exposure profile. The definition of exposure requires averaging over time that, in turn, results in a great deal of lost information. Intuitively, we may imagine that exposure to a very high concentration of contaminant for a short duration followed by exposure to no concentration at all for the remainder of say, a work shift may have different consequences from exposure to a modest concentration over the entire work shift. The total would be the same, but the duration and concentration of exposure would be different. For example, one worker may be welding for 15 minutes in a relatively enclosed space and be subjected to a concentration of metal fumes of 40 mg/m^3. He thus receives an exposure of 40 mg/m^3 × 0.25 h = 10 mg/m^3 × h. After welding, he goes on to different activities in a different part of the facility in which he experiences no concentration of welding fumes and thus receives no further exposure during the shift. His coworker, working in the same area but not exposed directly to the fumes, remains for the entire eight-hour shift. Measurement of metal fume concentrations over the course of the day in the location of the second worker gives 1.25 mg/m^3 . The worker in this location receives an identical exposure: 1.25 mg/m^3 × 8 h = 10 mg/m^3× h, but the pattern is different. (Robson, 2007)

To account for such differences, it is important for the exposure assessor to be cognizant of the magnitude, frequency, and duration of the exposure. Always ask, what is the peak concentration experienced during the monitoring period? Does it differ significantly from the mean concentration? How frequently are high concentration peaks found? Are the concentrations relatively stable, or is there a good deal of variability from minute to minute or hour to hour? Do you peaks recur regularly, or episodically? What is the duration of the exposure? Is it short followed by no exposure, or does it occur at moderate levels for a long period? Such information can prove invaluable in addressing potential effects and control strategies.

2.1.2.4 Methods of exposure assessment.

Exposure assessors typically undertake exposure assessment investigations in one of two ways: (1) **direct exposure** assessment methods and (2) **indirect exposure** assessment methods. Direct exposure assessment methods involve outfitting an individual with some type of monitor that measures pollutant concentrations experienced by the individual as he goes about his daily activities. This is most easily visualized for airborne contaminants. In this case, an air monitor collects a sample of the air breathed by the individual over a period of time. That air sample is then analyzed for the contaminants over a period of time. That air sample is then analyzed for the contaminant of interest either on a real-time or time-integrated basis (both are commonly used in occupational settings). Similar monitors may be envisioned for exposures occurring via the ingestion or dermal pathways as well. Actual exposures experienced by an individual can be observed by the direct method. This is a major strength in assessing exposure and is generally desirable. However, portable monitors may not exist for the particular contaminant under investigation, or may unduly influence the activity patterns of the individual; that is to say, the normal activities that are undertaken in the workplace. They also may be bulky, require electrical connection, or otherwise interfere with job duties.

An alternative strategy involves indirect exposure assessment, in which microenvironments, or areas or activities likely to give similar and relatively homogeneous exposures are monitored using, perhaps, more sophisticated monitoring equipment, and where the movement of the individual within and between such microenvironments is noted. Again, the inhalation route is most easily visualized. In this case, air pollution monitors are placed in various locations (e.g. workstations) to determine concentrations found in these locations. Exposure is then determined by having the individual note the amount of time spent in each of the microenvironments, multiplying the concentration measured by the amount of time spent in the microenvironment, and adding all such values together. For other routes of exposure, a similar approach can be used.

2.1.2.5 Biological markers of exposure.

Exposure to environmental contaminants requires the simultaneous presence. Both the direct and indirect method described above assumes that the exposure occurs if these two components exist. However, the only way to be sure is to use the response of the human subject as a measure. This is what exposure assessors do when they use biological markers of exposure. Biological markers of exposure to a given contaminant make use of biological material (e.g., exhaled breath, urine, blood or blood components, fecal samples, or tissues). These samples are analyzed for the contaminant in question, called the parent compound, or a metabolite or biological by-product to determine the exposure. Occupational exposure to trichloroethylene, an important industrial solvent, offers a good example. Urine samples can be taken from individuals and analyzed both for trichloroethylene and for its metabolites (e.g., trichloroacetic acid) to ascertain exposure to this class of compound. Using measures of these two compounds, we can infer the magnitude of the initial exposure and, through analysis of the metabolic processes involved, the timing of suck exposure (Finkel and Ryan 2007).

2.1.2.6 Other exposure-related issues.

It is interesting to note that exposure assessment t is not emphasized in occupational settings because PELs (and other OSHA standards) set the concentration limits through the use of standards similar to the National Ambient Air Quality Standards. Unlike the NAAQS, however, OSHA standards are compared to the actual exposures of individuals, rather than the environments they live or work in; an employer is deemed to be out of compliance if a personal air sampling device attached to a worker shows a concentration above (with statistical significance) a PEL.

Occupational PELs assume that a worker is employed over 45-year working lifetime (essentially from age 20 through ages 65) and that risk is accumulated during this period. Contrast this to the full 70-year lifetime assumed by the EPA when projecting cancer risk. Some have suggested that since individual industries and worksites are regulated, exposure-and thus risk-should only be accumulated during the time that the average worker remains with a single employer, perhaps 10 to 15 years. (Burmaster, 2000). This argument is weak in that workers normally change jobs within the same industry and are likely to continue accumulating exposure during their next job as well, if not to the identical substances then to similar ones that act via a common toxicological mechanism. Workers should be protected for their entire working lifetime.

OSHA. is required to perform exposure assessment when promulgating a regulation. It must, for example, account for the exposures experienced prior to the regulation being put in place and for likely compliance discrepancies. That may result in an over-or underexposure experienced by the workers themselves. This is especially noteworthy because in practice working facilities are normally considered to be in compliance if measured concentrations of contaminants at the site are less than 125 percent of the PEL. Further, compliance requirements allow conversion of exposure measurements that take place over less-than-full to full-shift exposures assuming zero exposure during the remaining shift time, biasing inferred exposures. In addition, no allowance is made for previous exposures; exposures are assumed to be fresh each day with no accumulated effects (Finkel and Ryan 2007).

2.1.3 Dose - Response Analysis

Dose-response analysis focuses on using animal data to predict health impacts on human subjects. Generally, a relatively small number of animals are exposed to the compound of interest at several levels, up to (and often including) the maximum tolerated dose, the highest dose of the chemical that when administered to animals does not cause any of a defined set of clearly adverse systemic health effects, such as substantial loss of body weight. In most cases, cancer is the ultimate outcome of interest, and tumor development in the animal is the way such an outcome is quantified.

The number of dose groups in such an investigation is quite limited, often consisting of no more than three or four; these may include a control group receiving no exposure, a maximum tolerated dose group that receives a high dose, and another group (or two) at some fraction of the maximum tolerated dose. In general, these doses are higher than might be experienced in a normal, non-occupational setting, even under the most adverse conditions (Finkel and Ryan 2007).

A significant question then becomes, how do we extrapolate the effect seen at the high levels of exposure experienced by the animals to the low levels experienced by the human subjects facing the exposure in an environmental or occupational setting? This is not as simple as it seems; there are many ways to do the low-dose extrapolation, and unfortunately they often give wildly different answers. The standard procedure for estimating the effect of low concentrations is a model known as *the linear multistage model* (LMS) in which the data for all of the dose groups are used to estimate the probability that an animal receiving a given dose would develop cancer. We will not discuss the details of the model here, but we will point out that there is an implicit assumption in the model that at low doses, the probability of an adverse health outcome increases linearly with increasing doses.

Once the data are fit using the LMS, we must account for differences between human beings and the rodents who are exposed and decide if we want to include safety factors in setting our standard. For non-occupational standards, the standard approach is to account for the differences in size between, say, mice and human beings, by scaling the dose by a function of the body weight (BW) ratio. In particular, EPA scales by B$W^{3/4}$ as EPA believes that metabolic processes scale approximately this way. EPA also supplies a small (no more than a factor of approximately 4, as can be seen in Hattis and Goble, 1991. margin of safety by looking at the quality of the statistical fit to the dose-group data and using an *upper confidence limit* (UCL) the linear slope value. That is, the statistical fit would give a number, called the *maximum likelihood estimate* (MLE), but EPA assumes a larger slope is plausible given the uncertainly in the observed response.

For occupational standards, a somewhat different approach is taken. The body weight extrapolation is done in a linear fashion; that is, the scaling is BW^{1}. This is less protective, by roughly a factor of 4 (when rat data are used) or 7 (mouse data) than $BW^{3/4}$. Further, the MLE estimate is taken, rather than the UCL on the plausible slope of the community standards, occupational standards may be modified to give a more conservative estimate under some circumstances. However, the factors are generally applied to the value determined above, the MLE estimate, rather than the UCL values.

One final different between the dose-response modeling used to develop occupational standards and those used in the broader setting is the way in which tumor data are used. In the community setting, tumor data collected from rodents is used in the aggregate. That is, all tumors are counted whether they are in the specific target organ or found elsewhere in the body. The converse is generally true in occupational dose-response analysis. For occupational standards, a specific target organ is specified and the number of tumors counted and used to develop the MLE discussed above. An example may clarify. Consider a case in which analysis of the high-dose group of rodents consisting of 50 animal's revealed tumors in 20 of these animals. Of these, 15 animals experienced liver tumors while 5 other animals experienced tumors in the other organs. For the general population, the number of positive outcomes would be 20, the total number of animals experiencing any kind of tumor, while for occupational dose-response analysis, only the tumors in the target organ, the liver, would be considered This lower figure is less protective, again emphasizing the point that occupational risk assessment tends to be less protective than community risk assessment. (Robson. 2000).

2.1.4 Risk Characterization.

The final step in risk assessment is determining the qualitative and/or quantitative estimation, including attendant uncertainties, of the probability of occurrence and severity of known or potential adverse health effects in a given population based on hazard identification, hazard characterization and exposure assessment. This step relies on the expertise of the assessor in analyzing the information. In this step, the dose-response relationship and exposure assessment are combined to describe the risk to subject persons. It is essential that persons responsible for conducting risk assessments be knowledgeable about the physical, biologic, and chemical hazards present in non-human-primate research. General principles of safety as they pertain to each hazard should be understood, including essential aspects of the laboratory, husbandry, and veterinary equipment in use; facility design elements, such as the systems for air handling and waste decontamination and disposal; systems of employee hygiene and medical surveillance; and how all these are integrated into the OHSP.

A framework of risk characterization to define the significance of the risk is developed, and all the assumptions, uncertainties, and scientific judgments from the proceeding these steps are considered. In many international regulatory frameworks environmental risk are often expressed as predicted environmental concentrations (PEC)/ predicted no environmental concentrations (PNEC) ratio i.e. as risk quotients. (Figure 3). For human risks a similar comparison between exposure and the no effects levels (NELs) is usually made. It should be note that these rations or Comparisons provide no absolute measure of risks. Nobody knows the real risks of chemical when exposure exceeds the PNEC or NEL. We only know that the likelihood of adverse effects increase as the exposure, effect level ratio increase. Then exposure effect ratio are internationally accepted substitutes for risk. It should also be noted that these is no such thing as precise assessments and scientific will always differ in the conclusion they draw from the same set data, particularly if the contain some implicit value judgments (Van Leeuwen and Vermeire 2007).

At the present level of understanding we cannot adequately predict adverse effects on ecosystems, nor can we predict what part of the human population will be affected. We are only able to assess risks in a very general and simplified manner. In fact, the best we can do is provided a relative risk ranking. Risk ranking enables us to compare single chemicals or group of chemicals once the risks of the respective chemicals have been assessed in a consistent "Simplified" manner. Nevertheless, relative risk ranking allows us to replace dangerous processes, techniques or chemicals with safer alternative in the risk management phase, without know in the precise risks.

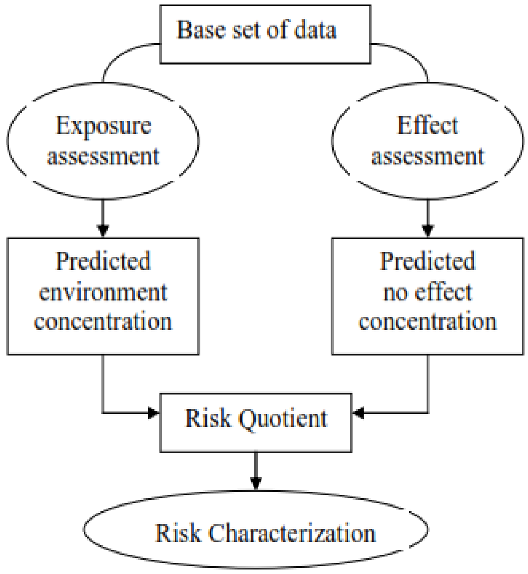


Figure 2 Risk characterization: a systemic procedure through estimation of exposure and effect (Applied from: Risk characteristic framework in (Van Leeuwen and Vermeire 2007).

2.1.5 Risk Management

The a decision making process of weighing policy alternatives in the light of the results of risk assessment and, if required, selecting and implementing appropriate control options, including regulatory measures and compare regulatory options and select the appropriate regulatory response to a potential health or environmental hazard .

Based on information obtained from the risk assessment, decisions are made about the best way to address environmental contamination and exposure. The risk manager also includes an evaluation of social, legal, economic, and policy issues to determine the best approach to address an exposure issue. Risk management decisions carried out by policy-makers are offer basic types: priority setting, selection of the most cost-effective method to prevent or reduce unacceptable risks, setting and evaluating compliance with standards or guidelines, and the evaluation of the success of risk mitigation efforts. Exposure information is crucial to these decisions. In addition to data exposures and related health effects, decision-makers also must account for the economic, engineering, legal, social and political aspects of the problem (Sexton, Selevan et al. 1992).

2.1.6 Risk Communication

The interactive exchange of information and opinions concerning risk and risk management among risk assessors, risk managers, consumers and other interested parties and those who may directly or indirectly be affected by risk management decision. Risk communication is the link between risk assessment and risk management. Stakeholders who could potentially be include in any particular risk assessment are representative, public pressure groups academic experts, specific consumer groups and privates citizens. These stakeholder can participate in a number of ways, including assessing in the development of management goals, proposing assessment endpoints providing valuable insight and information, and reviewing assessment results (Karkoszka and Szewieczek 2007, Van Leeuwen and Vermeire 2007).

2.2 History of incense and joss stick

Incense and joss stick has played an important role in many of the world's great religions. The Somali coast and the coasts of the Arabian Peninsula produced resin-bearing trees and shrubs including frankincense, myrrh, and the famous cedars of Lebanon. The cedar wood was transported all over the Tigris and Euphrates valleys, and the name Lebanon originated from a local word for incense. The ancient Egyptians staged elaborate expeditions over upper Africa to import the resins for daily worship before the sun god Amon-Ra and for the rites that accompanied burials. The smoke from the incense was thought to lift dead souls toward heaven. The Egyptians also made cosmetics and perfumes of incense mixed with oils or unguents and blended spices and herbs.

The Babylonians applied incense during prayers and rituals to try to manifest the gods; their favorites were resins from cypress, fir, and pine trees. They also relied on incense during exorcisms and for healing. They brought incense into Israel before the Babylonian Exile (586-538

B.C.), and incense became a part of ancient Jewish worship both before the Exile and after. True frankincense and myrrh from Arabia were widely used in the temples in Jerusalem during the times of Christ's teachings, although incense has fallen out of use in modern Jewish practice.

Both the ancient Greeks and Romans used incense to drive away demons and to gratify the gods. The early Greeks practiced many rites of sacrifice and eventually began substituting the burning of incense for live sacrifices. As a result of his conquest, Alexander the Great (356-323 B.C.) brought back many Persian plants, and the use of incense in civic ceremonies became commonplace in Greek life. Woods and resins were replaced by imported incense as the Roman Empire expanded. The Romans encountered fine myrrh in Arabia, and the conquerors carried it as incense with them across Europe.

By the fourth century A.D., the early Christians had incorporated incense burning into their practices, particularly the Eucharist when the ascending smoke was thought to carry prayers to heaven. Both the Western Catholic Church and the Eastern Orthodox Church used incense in services and processions, but incense has always been more intensely applied in the Eastern services. The Reformation ended the presence of incense in Protestant church practices, although its use returned to the Church of England after the Oxford Movement in the nineteenth century.

Incense and joss stick were always used more extensively in eastern religions. The Hindu, Buddhist, Taoist, and Shinto religions all burn incense in festivals, processions, and many daily rituals in which it is thought to honor ancestors. Incense burners, which are containers made of metal or pottery in which incense is burned directly or placed on hot coals, were first used in China as early as 2,000 B.C. and became an art form during China's Han dynasty (206 B.C.-220 A.D.). The Chinese also applied incense to a wide variety of uses including perfuming clothes, fumigating books to destroy bookworms, and scenting inks and papers. Even the fan (an import into China from Japan) was constructed with sandal-wood forming the ribs so the motion of the fan would spread the fragrance of the wood. In Japan, incense culture included special racks to hold kimonos so the smoke from burning incense could infiltrate the folds of these garments.

Head rests were also steeped in incense fumes to indirectly perfume the hair. (Tibetan incense., 2008)

2.2.1 Types of incense and joss stick products

Incense has appeared in many forms: raw woods, chopped herbs, pastes, powders, and even liquids or oils. What most of us think of as incense today is joss-sticks or cones? Cones as we know them were an invention of the Japanese and introduced at the World's Fair in Chicago in the late 1800's. When the Joss Stick or Masala incense first appeared in China by Buddhist monks around 200 BC. The process of extruding incense sticks and coils from finely ground incense materials seems to have begun in China.

Different type of joss stick is used for different occasions. Those slender and colored pale yellow ones are used for regular ceremonies whereas the spiral ones which are capable of burning longer are usually found in temples ceilings. During major festivals like the Festival of the Hungry Ghost and the elaborate and grand celebration worship of the Jade Emperor (Sky God) at Chew Jetty, joss sticks of large pillar size with affixed colorful carved dragons and phoenix motifs are offer to the gods.

Currently, a popular incense are made in the various countries; China, Japan, India, Vietnam, Cambodia, Bangladesh, and Thailand etc. There are different type of incenses and methods. Several incense and joss stick types are currently marketed as joss stick, incense, coil, cone etc. In the future, incense using is also likely to change. In India, two or three sticks of incense may be burned every day in a typical home, while in the United States, users of incense may only burn one stick a week. Incense-makers hope the variety, effectiveness, and low cost of incense sticks will make them more popular than air fresheners and room deodorizers made with artificial perfumes. Also, the popularity of meditation and aromatherapy have spurred incense sales among clients who want their rare moments of quiet and relaxation to be healing and beautifully scented.

Coin cone stick

Figure 3 Type of incense and joss stick

2.2.2 Incense stick manufacturing

By the 1960s, the emphasis was on the manufacture of joss sticks rather than incense wood milling. It appears that incense wood milling acted as a catalyst for the development of joss stick manufacturing since the latter depended very much on the availability of raw materials. Incense manufacture is a branch of the incense industry, which is a traditional activity in China dating back at least 400 years. It was first developed as a primary industry concentrating on the cultivation of and trade in incense trees. Then the industry gradually expanded into the manufacturing sector as incense wood or incense powder exported. After the exhaustion of the incense trees, the industry expanded completely into the industrial to making joss sticks from imported incense powder.

Eastern incense is processed from other plants. Sandalwood, patchouli, agar wood, and vetiver are harvested and ground using a large mortar and pestle. Water is added to make a paste, a little saltpeter (potassium nitrate) is mixed in to help the material burn uniformly, and the mix is processed in some form to be sold for burning. In India, this form is the *agarbatti* or incense stick, which consists of the incense mix spread on a stick of bamboo. The Chinese prefer the process of extruding the incense mix through a kind of sieve to form straight or curled strands, like small noodles, that can then be dried and burned. Extruded pieces left to dry as straight sticks of incense are called joss sticks. Incense paste is also shaped into characters from the Chinese alphabet or into maze-like shapes that are formed in molds and burn in patterns believed to bring good fortune. For all incense, burning releases the essential oils locked in the dried resin.

Incense comes from tree resins, as well as some flowers, seeds, roots, and barks that are aromatic. The ancient religions associated their gods with the natural environment, and fragrant plant materials were believed to drive away demons and encourage the gods to appear on earth; they also had the practical aspect of banishing disagreeable odors. There are two broad types of incense. Western incense is still used in churches today and comes almost exclusively from the gum resins in tree bark. The sticky gum on the family Christmas tree is just such a resin. The gum protects the tree or shrub by sealing cuts in the bark and preventing infection. In dry climates, this resin hardens quickly. It can be easily harvested by cutting it from the tree with a knife. These pieces of resin, called grains, are easy to carry and release their fragrance when they are sprinkled on burning coal.

In Thailand, Although it is more competition both domestically and internationally, a medium and large enterprises incense industry that has been growing However, that demand for incense using is higher, then the industry gradually expanded into the manufacturing sector as incense wood or incense powder exported. And incense manufacturing has more expanded to production in community. Because of production process is not complicated and not use advanced technology. At least four workers can do it and a widely rural location is suitable for incense and joss stick making. Many provinces are making incense and joss stick in village such as Ayutthaya, Chieng Mai, Uthaithani, Singhburi, Phatumtani and Roi-et and others. The several types of incense and methods were produced.

Generally , Incense and joss stick are made in villages , there are two ways by which incense products can be manufactured, namely the *"Toob Fun"* ***(ธูปฟื่น)*** method, and "*Toob Sud " **ธูปซัด)*** (method. The wood powders are the main raw material for incenses and joss stick manufacturing. Generally, the material for incense making consists of the following in the next contents.

2.2.3 Raw material for incense and joss stick making

2.2.3.1 Bamboo

The manufacture of joss sticks involves complex stages of processing. First of all, bamboo is felled and chopped into canes of different lengths to form the core of the joss sticks. Those products with bamboo cores are generally called "joss stick" *whilst* those without sticks are wound up and termed "incense coils". The bamboo from which the cores of the joss sticks come is varied. The most common type is called "Pencil Tube Bamboo". This type of bamboo has the property of being highly inflammable and also smooth on its surface. The sources of this species are China. However, these sticks are also highly susceptible to worms. In contrast, a certain type of bamboo from Thailand is more resistant to worms but is not so easily ignited. Perhaps the best type of bamboo comes from Vietnam. Saigon Bamboo, as it is often called, has the double advantage of high inflammability and resistance to worm. Not every factory can afford to buy this type of bamboo cane, however especially those engaging in the production of low-priced commodities, the bamboo exploited must be old and dry enough so that the bamboo core can support the immense weight added to it by the incense powder. As a result, bamboo bark and cambium are very seldom used as they arc cither too brittle or too slender. Instead, the xylem of old bamboo is used since it alone is hard enough. (Survey, 2009)

2.2.3.2 Glutinous incense powder โกวบั๊ว) or ผงก๊อ "Goow bowa")

This is a kind of powder obtained from a species of tree called *Persea Kurzii* Kosterm. Many glutinous incense powders come from different trees such as Bdellium, Benzion, Copal, Myrrh, Camphor, Sandarac etc. This powder has the characteristics of being sticky when wet so it is used to make the fragrant incense powder adhere to the bamboo canes.

Figure 4 Type of Glutinous incense powder

2.2.3.3 Incense wood powders

Sawdust The sawdust which is usually the end product of wood mostly generated in saw mills a waste product from the processing of wood, it may be from hard wood or soft wood. Sawdust is common type of incense powder used in ordinary. and used for mixed with incense powder, it is highly absorbent and retains fragrance well.

Figure 5 Type of sawdust

Fragrances incense powder.

For the fragrant incense powder, a number of varieties from different species and different parts of the tree would be mixed together. Within the broad categories of joss sticks and incense coils, incense products can be further sub-classified on the basis of their fragrances. In general, the fragrances of joss sticks include Aloe-scented, Sandal scented, Cypress-scented, Rose-scented, Lign-aloe-scented, benzoin scented and scentless. These different kinds of scents come from different kinds of fragrant trees. ***Sandalwood*** is obtained from *Santalun album,* the best of which is found in Sydney, Australia. Namely in Thailand called ***"Mai Chan"*** (Sandal wood).

It is this type of scent which is most favored by the public and is used in the production of both joss sticks and incense coils. Most of factories reported the use of various grades of sandalwood. The quality sandal wood powder from Western Australia and India that is imported. Sandalwood are healthier, burns longer and produces an aromatic smell but would cost much more to produce. On the other hand, those made from sawdust are harmful to the lungs, produces suffocating smoke and quick to blacken the walls and ceiling.

Figure 6 Sandal tree and Sandal powder

Occasionally, cypress wood or rosewood powder is added to the mixture. Very often, a chemically produced perfume of the scent jasmine or rose is added onto the outer coat of these joss sticks.

2.2.3.4 Colors powder

The outermost layer is a mixture of the most odoriferous incense powder and color powder. The color powder is either rose red powder which is red in color, or mustard yellow powder which is yellow in color. Some of colors powder may be have heavy metal such as lead and other chemicals.

2.2.3.5 Perfumes oil and powder

After dried sticks are then scented using a combination of different perfumes, this is the most value- adding in joss stick production, and the formula for blending perfumes and aromatic ingredients is a trade secret – and other ingredients such as aromatic oil.

There are two classification methods of incense manufacturing in villages by which incense products can be manufactured, namely the ***" Toob Fun "*** method, the ***"Toob Sad"*** method, the process of production each of the method following:

"Toob Sad" **method:**

- The method of mass production by which the incenses and joss ticks are produced bundle by bundle. The joss stick worker first mixes the different incense powders in the correct proportion. There are more or less 6 types of powder mixed together in the manufacture of each coat of the joss sticks. The most basic one is a glutinous incense powder, namely *" Goow Bowa" โกวบั๊ว or ผงก๊อ*. This is a kind of powder obtained from a species of tree called *Persea Kurzii* Kosterm. This powder has the characteristics of being sticky when wet so it is used to make the fragrant incense powder adhere to the bamboo canes. The method are manufactured manually by immerse a bundle of bamboo stick in water and rolling the wood powder onto the sticks. Worker then shake the layered sticks to remove loose powders. This procedure is repeated as wood powders are firmly rolled on the sticks layer by layer until a desirable size is reached, approximately four to six layer for a standard size joss stick and eight to ten for a large size. The joss sticks are then collected and spread under the sun for drying. This process is best accomplished under the sun, as the sunlight, in evaporating the water content of the incense powder, keeps the scent and the color of the sticks. Drying takes 5-6 hours under bright sunlight and 8-9 hours on cloudy days. Halfway through the drying process, a worker will collect the joss sticks and dye the handles of the joss sticks with red or yellow paint. The dyed sticks are then spread out once again under the sun for drying. After the joss stick products are dried, some may be sprayed with perfumes or dipped in the fragrance. They are again left on shelves to dry overnight. After the incense products are dried, they are ready for packaging. The most common type of packaging is by wrapping in transparent plastic. Sometimes, some incense and joss sticks are put into plastics bags, paper bags or paper boxes. The step of the incense and joss stick method are following :

1. Preparation of bamboo for incense and joss stick.
2. Mixing different incense powders together
3. Immerse a bundle of bamboo stick in water and rolling and shaking wood powder onto the sticks. After then lead to drying under the sun.
4. Dipping into an incense colored and dying incense sticks.
5. Leading incense and joss stick to dry under the sun.
6. Spraying aromatic perfume and packaging is by wrapping in transparent plastic.

***"Toob Fun"* method**

The method is not popular production, and requires individual attention to each stick. The manufacturing process is done entirely with bare hands; glutinous incense powder and fragrant incense powder are mixed with water and kneaded to form dough. These joss sticks are made by rubbing the incense paste onto the surface of a bamboo cane, and then colors powder is rubbed onto the outer surface. A wooden slab is used to smooth the surface of the stick. The joss sticks manufactured by this method have one coat of incense powder only. The sticks are hung in a sheltered but well ventilated place. The joss sticks produced do not necessarily have to be dried under the sun. They can either be blown dry. Drying under direct sunlight is strictly avoided as the high speed of evaporation will result in cracks on the surface. The steps of process of a second method *, " Toob Fun "* method by mixing , glutinous incense powder and fragrant incense powder are mixed with water and Kneading, a mixer to form a dough and then Rubbing and rolling the incense paste onto surface bamboo cane when finish , hung in a sheltered but well ventilated place. It is not necessarily to be dried under the sun.

Two methods are classification of incense and joss stick products as manufacturing in the villages. Most of manually production are made in houses and distributed around country. However, incense and joss stick production to make a higher community income. However, dust is the primary waste material from the production process. It is hazardous and dangerous to health. There is a considerable risk to those with respiratory and allergies. Potential workers are warned that the natural components of the sticks and the fragrances may cause allergic reactions due to dermatitis and asthma.

2.3 Potential hazardous exposure in incense making

The hazard of incense making include toxic hazards associated with the base materials, and physical hazards relate to ergonomic. Workers who make incenses may be exposed to a wide range of potentially hazardous materials in making process. The wood dust is a major material which use in production. These may lead to the generation of particular of wood dust, some of which are small enough to be inhaled deeply in to the lung.

Occupational exposure to wood dust has been well established as a cause of nasal cancer and respiratory tract cancer, skin and eye irritation, rhinitis, dermal allergic reaction, asthma and pulmonary function defects (Demers, Boffetta et al. 1995, Okwari, Antai et al. 2005, Aguwa, Okeke et al. 2007). A case of joss stick lung was reported in a Japanese joss stick manufacturing worker employed for more than 50 years and only the previous studied in Taiwan, 1996 by Lion et al (Lion, Yang et al. 1996). They studied to respiratory symptoms and pulmonary function among wood dust exposed joss stick workers manufacturing in Taiwan. The results showed the problems of pulmonary function defect in workers who exposed to wood dust in processing (Lion, Yang et al. 1996). However, there are few epidemiology studies of health hazard associated with joss stick worker. Although there are many incenses manufacturing, especially in Asia such as China, Japan, India, Bangladesh, Vietnam, Cambodia, and Thailand.

2.4 Wood dust

Wood is an important worldwide renewable natural resource. Forests extend over approximately one-third of the earth's total landmass. There are an estimated 12,000 species of trees, each producing a characteristic type of wood; therefore, the species of trees harvested vary considerably among different countries and even among different parts of a single country. However, even in countries with high domestic production of wood, some wood may be imported for specific uses, such as furniture production (IARC. 1995).

Wood is classified as either softwood or hard wood. Softwood comes from conifers trees such as spruce, pine, and fir. Hard wood come from deciduous trees such as oak, alder and maple. There are several substances in wood dust including cellulose, hemi-cellulose, fatty acids, polyposis, lignines, alkaloids, carbohydrate, protein and various inorganic plus hundreds of high and low molecular weight compound which serve a variety functions, including protecting the wood from attack by insects etc. These include terpenes, lignin, stibenes, tannins, quinines, and phenols. In addition, wood can be contaminated by fungus, molds, and insects, which can be irritants or allergenic in their own right. Wood often treated with a variety of other toxic compounds including copper, arsenic, formaldehyde, and pentochlophenol as preservatives, in production of wood fiber products and plywood may be contaminated with lead in paint, epoxy and glues and other chemicals (Noertjojo, Dimich-Ward et al. 1996, Puntarić, Kos et al. 2005).

Wood dust is defined as wood particles or a general term covering a wide variety of airborne wood dusts, which are produced during the processing and handling of both hard and softwood, chipboard, hardboard, and other composite materials. (HSE. 2003). It is a light brown or tan fibrous powder which its specific gravity as 0.56. (NIP. 2001) There is varies in particle size from less than a micron to very large particles in 30-40 micron range. Some studies reported that the particle size distribution varied according to the woodworking operation, with sanding producing smaller particles than sawing, but others found no consistent differences. (IARC. 1995).

Most wood dust particulates have average diameters of greater than 5 microns, and extend down to less than 1 micron in size. Particles less than 2.5 microns are classified as respiratory suspended particle (RSP). The small particle can invade into the deeper of the lung with to serious health. Most exposure to wood dust occurs when individuals use machinery or tools to cut or shape wood. Breathing in the dust causes it to deposit in the nose, throat, and other airways. The amount of dust deposited within the airways depends on the size, shape, and density of the dust particles and the strength of the airflow. Particles with a diameter larger than 5 micros (“inspirable” particles) are deposited almost completely in the nose. Particles 0.5 - 5 micros (“respirable” particles) are deposited in the lower airways. Some studies reported that the particle size distribution varied according to the woodworking operation, with sanding producing smaller particles than sawing, but others found no consistent differences. The majority of the wood dust mass was reported to be contributed by particles larger than 10 m in aerodynamic diameter, and between 61% and 65% of the particles measured between 1 and 5 m in diameter (IARC.,1981; 1995).

Total airborne dust concentrations are described as mass per unit volume (usually milligrams per cubic meter). Wood dust generally is collected by a standard gravimetric method that involves using a sampling pump to collect a known volume of air through a special membrane filter contained in a plastic cassette. The detection limit for personal sampling of wood dust is approximately 0.1 mg/m^3. Inspirable dust includes large particles that may deposit in the respiratory system. Finer, respirable dust is sampled through a 10-mm nylon cyclone (centrifugal separator) that is designed to accept 50 percent of unit density spherical particles of 3.5-μm aerodynamic diameter. Samplers that measure inspirable wood dust concentrations must maintain a sampling efficiency of greater than 50 percent for particles up to 100 μm aerodynamic diameter (Weber, Kullman et al. 1993).

The national Institute for Occupational Safety and Health (NIOSH) sampling method (NIOSH Method 0500) for total airborne dust consists of collecting dusts on tarred 37-mm hydrophobic filters (PVC, 2-μm to 5-μm pore size or equivalent). Sampling rates of 1 to 2 L/min are recommended, with a recommended filter maximum dust loading of 2 mg of total dusts. Dusts weights are determined with a microbalance capable of weighing to 0.001 mg, and dust concentrations are expressed as milligrams per cubic meter of total dust. (NIOSH. 1994).

2.4.1 Evaluate wood dust concentration

Several organizations, including the American Conference of Governmental Industrial Hygienists (ACGIH) and the International Standards Organization, have proposed particle-size-selective sampling methods. For wood dusts, the appropriate exposure measure is the inspirable mass, which is defined as those materials that are deposited anywhere in the respiratory tract.

The ACGIH has defined the sampling characteristics of inhalable mass samplers to have a samplings efficiency of 50% for particles of 100-μm aerodynamic diameter. Sampling devices that meet these criteria have been developed and used for sampling wood dusts (Hinds 1988, Weber, Kullman et al. 1993).

NIOSH recommends that wood dust (soft, hard, and western red cedar) be considered a potential occupational carcinogen and that exposure is limited to 1 mg/m^3 as a TWA exposure up to a 10-hour workday during a 40-hour workweek. OSHA. regulation has applied to workplaces where wood dust is present primarily control safety hazards of the environment (e.g., in sawmills). Teschke *et al.* had analyzed 1,632 measurements of personal time-weighted-average airborne wood dust concentrations in 609 establishments on 634 inspection visits that were reported to the Occupational Safety and Health Administration (OSHA.) Integratedn Management Information System between 1979 and 1997. Exposures ranged from less than 0.03 to 604 mg/m^3, with an arithmetic mean of 7.93 mg/m^3 and a geometric mean of 1.86 mg/m^3. Exposure levels have decreased significantly over time (the unadjusted geometric mean was 4.59 mg/m^3 in 1979 and 0.14 mg/m^3 in 1997). While a multiple regression model to predict wood dust exposure levels by such factors as year, state, job, and industry. Values predicted by the model fell in the range of 0.015 to 36.0 mg/m^3, with a geometric mean of 1.85 ± 2.95 mg/m^3.

The ACGIH assigned threshold limit values of 1 mg/m^3 for certain hardwoods, such as beech and oak, and 5 mg/m^3 for softwoods except western red cedar, as time-weighted averages (TWAs) for a normal 8-hour workday and a 40-hour workweek. It also established a short-term exposure limit (STEL) of 10 mg/m^3 for softwood, for periods not to exceed 15 minutes. Exposures at the STEL concentration should not be repeated more than four times a day and should be separated by intervals of at least 60 minutes. And assigned western red cedar dust a TLV of 0.5 $mg/m^{3.}$ (ACGIH.,1994; 2004). Because of its suspected involvement as an asthmatic trigger and sensitizer by referred to the studied in western red cedar showed that the causative agent in western red cedar dust induced asthma and affects between 4 and 13.5 % of exposed population (Chan-Yeung 1994). OSHA also established a permissible exposure limit of 15 mg/m^3 for the total dust and 5 mg/m^3 for the respirable fraction of wood dust.

In Thailand, Ministry of Labor assigned threshold limit values of 5 mg/m^3 for respirable dust size less than 10 microns, and 15 mg/m^3 for total dust, as time-weighted averages (TWAs) for a normal 8-hour workday and a 40-hour workweek. Recommendation for wood dust exposure have been settled by several organization as following by table1 (Recommendation for wood dust exposure)

Table 2.1: Recommendation for wood dust exposure by several organization.

Organization/Agency	Standard level
OSHA PEL	15 mg/m^3 as total dust
NIOSH REL	1 mg/m^3 as total dust
AGGIH TLVs (current 2000):A1 - certain hardwood such as beech and oak softwood	TWA 5 mg/m^3, TWA 5 mg/m^3, STEL 10 mg/m^3
ACGIH TLVs (proposed 2000) -Hardwood and softwood (no- allergenic: A4) - Beech and oak: SEN; A1 - Birch, Mahogany, Teak, Walnut: SEN;A2 - Softwood and other Hardwood (allergenic): SEN;A4 - Western red elder: SEN;A4	TWA 5 mg/m^3 TWA 5 mg/m^3 TWA 5 mg/m^3 TWA 5 mg/m^3 TWA 0.5 mg/m^3
Thailand : Ministry of Labor - Reparable dust; sized less than 10 microns - Total dust	TWA 5 mg/m^3 TWA 15 mg/m^3

2.4.2 Recommendation of Occupational Exposure Limits

The Japan Society for Occupational Health (JSOH.) recommends the Occupational Exposure Limits (OELs.) as reference values for preventing adverse health effects on workers caused by occupational exposure to dusts (JSOH., 2008-2009) as following by table 2 (Occupational exposure Limits for dusts**)**.

Table 2.2 Occupational exposure Limits for dusts

I. Respirable crystalline silica[#,Ɨ,ψ,*]

OEL-C 0.03 mg/m^3

II. Dusts other than I

Class-	Dusts	OEL (mg/m^3)	
		Respirable dust*	Total dust**
Class 1	Activated charcoal, Alumina, Aluminum, Bentonite, Diatomine, Graphite, Kaolinite, Pagodite, Pyrites, Pyrite cinder, Talc[Ɨ]	0.5	2
Class 2	Dusts containing less than 10% free silica, Bakelite, Carbon black, Coal, Cork dust, Cotton dust, Iron oxide, Grain dust, ***Joss stick material dust***, Marble, Portland cement, Titanium oxide, ***Wood dust***, Zinc oxide	1	4
Class 3	Limestone[Ɨ], Inorganic and organic dusts other than Classes 1 and 2	2	8
Asbestos***,[Ɨ]		(Table III-2)	

2.5 Health Effects From Exposure to wood Dust

Wood dust exposure occurs whenever wood is sawed chipped, planed, routed, sanded and others production which related to wood dust. In 200-2003, the estimated occupational exposure to inhalable wood dust in the member states of the European Union, the data showed that about 3.6 million workers (2.0% of the employed EU-25 population) were occupationally exposed to inhalable wood dust. There were construction employed 1.2 million exposed workers (33%), mostly construction carpenters, The numbers of exposed workers were 700,000 (20%) in the furniture industry, 300,000 (9%) in the manufacture of builders' carpentry, 200,000 (5%) in sawmilling, 150,000 (4%) in forestry and <100,000 in other wood industries. there were 700,000 exposed workers (20%) in miscellaneous industries employing carpenters, joiners and other woodworkers. The highest exposure levels were estimated to occur in the construction sector and furniture industry. About 560,000 workers (16% of the exposed) may be exposed to a level exceeding 5 mg/m^{-3} (Kauppinen, Vincent et al. 2006).

Exposure wood dust may cause external and internal health problems. The health effects vary with the intensity and duration of exposure and size of particles. Particles in the eye may cause irritation, and wood dust gathering in the skin folds may be aggravated by perspiration and chemical and lead to irritation and infection. (Encyclopedias of occupational health and safety., 1998)

The effects from exposure to wood dust are due to chemicals in the wood or chemical substances in the wood created by bacteria, fungi or molds. Chemical in wood may be absorbed into the body through the skin, lung or digestive system. Health effect can include headaches giddiness, weight loss, breathlessness, cramp, and irregular heartbeat. Toxic wood are typically hardwoods such as teak, yew, oleander, laburnum, and mansonia. (Workplace health safety, 2000)

Table 2.3 Summarizes the health effects reported for exposures to various type of wood.

Wood type/found	Use	Health effect
Alder (common, black, red) (Europe,NorthAmerica, western Asia)	Toys, general turnery, broom and brush backs	Dermatitis associated with black alder, no reports with red alder, decrease in lung function (red alder)
Beech (Europe)	Furniture, bobbins, brush backs, handles, domestic woodware, flooring, plywood manufacture, instruments	Dermatitis (wood cutters' disease) due to lichens growing on the bark of beech trees, rhinitis, asthma, nasal cancer
Birch (paper,white) (US and Canada (paper birch) Europe (white birch)	Furniture, decorative objects, pulp and paper	Irritants Dermatitis
Cedar, Western Red (West coast of North America)	Building construction material, boats, planking, framing	Asthma, allergic contact dermatitis, sensitizer, decrease in lung function, eye irritation and conjunctivitis, rhinitis
Douglas Fir (West coast of North America and Europe)	Interior and exterior construction, flooring, boats, veneer, furniture	Contact eczema, decrease in lung capacity
Fir (grand, balsam, silver, alpine) (US and Canada Europe (silver fir)	Interior construction, joiner, plywood.	Skin irritation, dermatitis, rhinitis, asthma, possible decrease in lung function.
Hemlock (North America)	Furniture, cabinetry	Skin irritation, decreased lung function

Larch (North America and Europe)	Construction, frame work, boats, flooring	Allergic dermatitis from European larch, no reports with western larch
Mahogany (Africa)	Furniture, cabinetry, boats, moldings, etc.- all- purpose wood, used where good quality wood is required	Dermatitis, sensitizer
Maple (North America and Europe)	Furniture, interior construction, cabinets	Rhinitis, asthma, Maple Bark Strippers' Disease (mould spores in bark)
Oak (North America and Europe)	Furniture, decorative veneer	Nasal cancer
Pine(white, lodge pole, jack) Europe, North America	Interior and exterior construction, pulp and paper	Skin irritation, contact dermatitis, Wood-Pulp Workers' Disease (mould in bark), rhinitis, and asthma
Rosewood (South America, Asia)	Decorative veneer, furniture, cabinets instruments	Eczema, allergic contact dermatitis
Spruce (North America and Europe)	Interior and exterior construction, furniture, pulp and paper	Skin irritation, Wood-Pulp Workers' Disease (mould spores in bark), decrease in lung function
Teak (Asia, Africa, West India)	Ship building, interior fittings and molding, furniture, flooring.	Toxic, dermatitis, sensitizer
Yew (Europe, Asia, North Africa)	Carving, veneer, cabinet making	Irritation of Skin, dermatitis.

Developed from: workplace health safety; health effects from exposure to wood dust 2009.

Workers exposed to wood dust need to understand the potential health effects of such exposure and take precautions to reduce their exposure.

2.5.1 Irritation of the eyes, nose and throat

Chronic exposure to wood dust can cause impaired nasal mucociliary clearance and impair olfactory sensitivity. These may lead to irritation, frequent sneezing, nosebleeds, a runny nose (rhinitis). Many hardwoods and softwoods contain chemicals that can irritate the eyes, nose and throat, causing shortness of breath, dryness and soreness of the throat, sneezing, tearing and conjunctivitis (inflammation of the mucous membranes of the eye). Many wood workers report nasal symptoms including nasal discharge, blocked nose or sinus trouble related to their exposure to general dust. Some studies have shown some changes to the lining of the nose which could in part be related to the symptoms (Demers, Boffetta et al. 1995, Okwari, Antai et al. 2005). In 2001, Laraqui *et al.* 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, conjunctivitis, chronic bronchitis and dermatitis were significantly in exposed workers than non-exposed. Smoking exhibited a potential effect on airborne contaminants because among exposed workers disorders were 1.8 times more frequent in smokers than non-smokers (Knight, Levin et al. 2001). In addition, the study of Osman *et al*. (2007), this study was to estimate occupational exposure to wood dust in the furniture industry in a minor industrial estate in Bursa Turkey. The study was conducted between October 2006 and May 2007. A total of 656 persons, 328 woodworkers and controls were included. It also was reported that 176 of workers (53.7%) had blocked nose while working, 141 (43.0%) had redness of the eyes, 135 (41.2%) had itching eyes and 78 (23.8%) had runny nose (Osman, Douglas et al. 2007).

2.5.2. Dermatitis

Some woods such as teak, mansonia and radiate pine, contain chemical that are irritants (see table extended list of wood species, their geographic origins and their health effects). Some species may cause allergic contact dermatitis such as Douglas fir, western red cedar, poplar, rosewood, mahogany. (Encyclopedias of occupational health and safety., 1998). Dermatitis from wood dust contact, the effect may tend to appear on every part bodies ; arms, hands, face ,neck scalp and genital etc. An average 15 days to develop symptom after contacted, Symptom usually only persist as long as the affects skin site remain in contact with source of irritation. Symptom subsides when contact with the irritant is removed. A condition in which the skin can become red, itchy, or dry, and blisters may develop. Wood dust in direct contact with the skin can also cause dermatitis. With repeated exposures, a worker can become sensitized to the dust and develop allergic dermatitis. Once a worker becomes sensitized, exposure to small amounts of dust can cause a reaction that becomes more severe with repeated exposures.

2.5.3. Respiratory system effects

Respiratory system effects due to wood dust exposure include decreased lung capacity and allergic reactions in the lungs. Two types of allergic reaction can take place in the lungs: hypersensitivity pneumonitis (inflammation of the walls of the air sacs and small airways) and occupational asthma. Decreased lung capacity is caused by mechanical or chemical irritation of lung tissue by the dust. This irritation causes the airways to narrow, reducing the volume of air taken into the lungs and producing breathlessness. It usually takes a long time to see a reduction in lung capacity.

Studies showed that sawmill workers exposed to softwood dusts arising from Douglas fir, western hemlock, spruce, balsam, and alpine fir had reduced lung function. In a 1995 study which looked at a group of sawmill workers in Alberta who were processing pine and spruce for a least three years, workers who smoked and were exposed to wood dust were more greatly affected than workers who did not smoke. This condition can worsen during the work week and improve during a worker’s days off. Over the long term, some workers may develop a permanent decrease in lung function (COPD) (Hessel, Herbert et al. 1995). The investigating the relationship between changes in lung function and cumulative exposure to wood dust both of the 6 years longitudinal studies in 1996 and 2008 (Demers, Boffetta et al. 1995, Jacobsen, Schlünssen et al. 2008). First, studied in 350,000 males in United States, the 11,541 individuals who reported having been employed in wood related occupations had a lower relative risk of mortality due to non-malignant respiratory disease than those who did not reports exposure to wood dust (Demers, Boffetta et al. 1995). And the second study, to investigate and followed up in 1,112 woodworkers (927 male and 185 female) and 235 controls. a significant decrease in exposure was identified from the initial period 1997-1998 to 2003-2004. At baseline it was 0.94 +/- 2.10 mg/yr/M3, and at follow-up it was 0.60+/- 1.60mg/yr/M3. The results showed a significant decrease in lung function among female woodworkers compared to controls. (Jacobsen et al., 2008)

- ***Hypersensitivity pneumonitis*** appears to be triggered when small particles penetrate deeply into the lungs where they trigger an allergic response. Particles that are known or suspected to cause this condition include moulds, bacteria, and the fine dust from some tropical hardwoods. The initial effects can develop within hours or after several days following exposure and are often confused with flu or cold symptoms as headache, chills, sweating, nausea, breathlessness, and other fever symptoms . Tightness of the chest and breathlessness often occur and can be severe. With exposure over a long period of time, this condition can worsen, causing permanent damage to the lungs. The walls of the air sacs thicken and stiffen, making breathing difficult. Some diseases that have been classified as hypersensitivity pneumonitis include maple bark strippers' disease, sequoiosis (from breathing redwood dust containing mould particles), wood trimmers' disease, and wood-pulp workers' disease. These diseases are caused by moulds growing on the wood rather than the wood dust itself. The mould spores become airborne when wood chips are moved, lumber is trimmed, and bark is stripped. In sawmill workers in Hessel et al., 1995 had observed exposure to bioaerosols in 111 sawmill workers in Switzerland. They found that the airborne concentration of fungi exceeded the Swiss recommended limit and was associated with "bronchial syndrome" such as cough and expectoration, but there was not an associated decline in lung function (Hessel, Herbert et al. 1995). This is contrast with William 's studied in 2005, did a critical analysis of studies concerning reports of respiratory sensitization to certain wood dusts used in the US (oak, beech, pine, and western red cedar). The effects seen in the studies were due to underlying bronchial hyperactivity, not allergic sensitization (Williams 2005).

- ***Asthma***. is a chronic inflammatory disorder of the airways characterized by reversible (fully or partially) bronchial tube spasm. Symptoms include wheezing or coughing, shortness of breath, with wheeze, cough and/or prolonged expiration on chest examination, and decreased FEV1 on spirometry. Common findings on histopathology include inflammatory cell infiltration, hypertrophy of smooth muscle, hyperplasia of goblet cells, airway edema, and denudation of airway epithelium. Asthma affects approximately of the population. Identifiable pre-disposing factors include atopy and obesity. There are an estimated 34 million people with diagnosis of asthma in US, and over 40 million with allergic rhinitis. About 9-15 percent of adult onset asthma is considered to be occupational, with rates varying by country and level of industrialization. Asthma due to wood dust exposure has been reported for decades. A specific wood dust exposure is the subject of many individual case reports from around the world (Fernández-Rivas, Pérez-Carral et al. 1997, Douwes, McLean et al. 2001, Algranti, Mendonça et al. 2004, Eire, Pineda et al. 2006).

Some wood such as western red cedar is the most studied wood with respect to wood dust relate asthma. It has been estimated that at least five percent of forest industry workers in British Columbia exposed to cedar dust are allergic to it. The first symptoms of asthma due to exposure to western red cedar usually begin late at night and resemble a cold (eye and nose irritation, stuffiness, runny nose, dry cough, and tightness in the chest). Eye and nose irritation can slowly improve, leaving wheezing and coughing as the only symptoms. With prolonged exposure, wheezing and coughing happen during the day as well. In some cases, the asthma attacks can start after only a few weeks of contact with cedar dust (Chan-Yeung 1994). Eastern white cedar has also been found to be allergenic, with the same etiologic agent plicatiic acid (Malo, Cartier et al. 1995). In contrast, pine dust as an allergen was investigated by Skovsted *et al*.,(2003), evaluating 365 exposed and 116 non exposed workers. Some exposed and some non- exposed were found to have IgE. antibodies to pine, but small percentages (Skovsted, Schlünssen et al. 2003). A study evaluated health effects of exposure to the tree which produces natural rubber latex, evaluating 103 workers and 76 unexposed, and found a dose dependent increase in wheeze, nasal symptoms ,asthma and reduced spirometric values. Exposure to oak and beech dust was found to cause sore throat and bronchial hyperresonsiveness but not decline in FEV1 with increasing dose and duration. An another studies which involved asthma symptom related to wood dust exposure, *Fransman et al*., 2003 studied work exposure and respiratory symptoms in New Zealand plywood mill workers. Founded that asthma symptoms more common in plywood mill workers than in the general population (20.5% and 12.8%, respectively). Asthma symptoms were associated with duration of employment and were reported to lessen or disappear during holidays (FRANSMAN, McLEAN et al. 2003). In consistent with of the previous studied, *Schlunssen et al., 2004* studied to the relation between wood dust exposure and different indices of asthma among 302 woodworkers and 71 non-exposed subjects. There was a tendency to increased risk of asthma among atopic woodworkers compared to a topic non-exposed subjects, with ORs between 3.0 (0.8-11.9) (symptomatic BHR) and 1.3 (0.5-4.2) (work related symptoms). In woodworkers, asthma was associated with atopy, with ORs between 7.4 (2.8-19.7) (symptomatic BHR) and 4.2 (2.4-7.7) (asthma symptoms). Asthma was related to dust level, most pronounced for symptomatic BHR among atopics, with OR 22.9 (1.0-523.6) for the highest compared to the lowest dust level. For work related asthma symptoms the association with dust level was seen only for non-atopics. Wood dust exposure was associated with asthma, despite a low dust level compared to other studies. Atopy was an important effect modifier in the association between asthma and wood dust exposure (Schlünssen, Sigsgaard et al. 2004). In addition, The meta-analysis on wood dust exposure and risk of asthma by Perez Rios *et al*. was published in Allergy 2009. A quality scale for study selection was applied and nineteen studies were included, (3 cohort, 12 case control and 4 mortality studies). The pooled RR was 1.53 (95% CI 1.25-1.87). For studies of Caucasians alone the results were 1.59 (95% CI 1.26-2.00), and studies of Asian populations 1.15 (95%CI 0.92-1.44). There are currently several researches to relationship between asthma and wood dust exposure. Most of studies were conducted in wood factory such as furniture, sawmill, plywood industry etc (Pérez-Ríos, Ruano-Ravina et al. 2010).

- Pulmonary capacity defected The pulmonary function defected from wood dust exposure were recorded in several studies. An evaluation respiratory status normally uses the primary tools called, spirometry, the physiological test that measure how an individual inhale or exhales volumes of air as a function of time. The primary signal measured in spirometry may be volume or flow. That is, spirometry with flow volumm loups assesses the mechanical properties of respiratory system by measuring expiratory volumm and flow rates. There are several studies mentioned to abnormal lung function among workers who exposed to wood dust in wood industry. In 1992, Shamsain studied to pulmonary function, and respiratory symptoms (cough, phlegm, breathlessness, wheezing, and nasal symptoms) in 145 non-smoking workers (77 male, 68 female) exposed to wood dust in a furniture factory in Umtata, Republic of Transkei, and 152 non-smoking control subjects (77 male, 75 female) from a bottling factory with a clean environment. After adjustment for age and standing height the forced expiratory indices were significantly lower in the exposed male workers than in the control subjects. FEF and PEF in the exposed men were 81.3% and 89.4% of predicted values and were lower than other indices. FVC in exposed men showed a significant inverse correlation with exposure (expressed in number of years of employment). The FVC was reduced by 26 ml per year of employment. The proportion of men with an FEV1/FVC below 70 was higher in exposed workers than in control subjects and higher in the exposed workers with more years of employment. The exposed workers had more respiratory symptoms than the control subjects, the prevalence, especially of cough and nasal symptoms, increasing with the increase in the number of years of employment. Workers exposed to pine and fiber dust have more respiratory symptoms and a greater risk of airflow obstruction. And Also with Okwari studied in 2005 found that the effect of chronic exposure to dust from local woods such as ebony, achi, and iroko on lung function of timber market workers in Calabar - Nigeria, was studied. Forced vital capacity (FVC), Forced Expiratory

Volume in one second, (FEV1), Forced Expiratory Volume as a percentage of forced vital capacity (FEV1 %), and Peak Expiratory Flow Rate (PEFR) were measured in 221 workers (aged 20-25 years) exposed to wood dust to assess their lung function and compared with 20 age- and sex-matched control subjects who were not exposed to any known air pollutant. The concentration of respirable dust was significantly higher in the test (P<0.001) than in control site. The mean values of FVC, FEV1, FEV1% and PEFR of the timber workers were significantly lower (P<0.01) than in control subjects (Okwari, Antai et al. 2005). Moreover, Like, Larama *et al.* (2004) and Osman and Pala *et al.* (2009) studied to evaluate lung function among workers exposed to wood dust. The results also showed the exposed to wood dust adversely influenced the workers respiratory functions (Rongo, Msamanga et al. 2004, Osman and Pala 2009).

2.5.4. Carcinogenicity

Wood dust has been associated with cancer of the respiratory tract in a number of studies, and has been identified as a carcinogen by IARC, NTP and most recently, by California's OEHHA, based on sufficient evidence of carcinogenicity from studies in humans. An association between wood dust exposure and cancer of the nose has been observed in many case reports, cohort studies, and case-control studies that specifically addressed nasal cancer. Many additional studies have shown that workers employed in logging, sawmills, furniture and cabinet making, and carpentry are at an increased risk of developing nasal cancer. Demers *et al.,*(2009) combined cohort consisted of 28,704 persons from five studies: British furniture workers, members of the union representing furniture workers in the United States, two cohorts of plywood workers, and one of wood model makers, among whom 7,665 deaths occurred. Pooled analyses were carried out for all of the cohorts combined, the two furniture worker cohorts combined, and the two plywood workers cohorts combined. The results showed a significant excesses of nasal (observed 11, standardized mortality ratio (SMR) 3.1,95% confidence interval (95% CL) 1.6-5.6] and nasopharyngeal cancer (observed 9, SMR 2.4, 95% CL 1.1-4.5) were observed. That for nasal cancer appeared to be associated with both high and low probability of wood dust exposure. No excesses of lung, larynx, stomach or colon cancer were found to be associated with any surrogate indicators of wood dust exposure. Workers exposed to wood dust may have an excess risk of nasopharyngeal cancer and multiple myeloma in addition to sino-nasal cancer.. An unusually high incidence of nasal cancer has been described among woodworker in Australia, Canada, Denmark, Finland, Frence, Italy, the Netherland, the United Kingdom and the United States. A recent pooled re-analysis of 12 case –control cohort studies conducted in seven countries confirmed a high risk of nasopharyngeal cancer among wood worker (Demers, Boffetta et al. 1995). Other types of nasal cancer (squamous-cell carcinoma of the nasal cavity) and cancer at other sites, including cancer of nasopharynx and larynx and Hodgkin's disease, have been associated with exposure to wood dust in several epidemiologic studies.

The particulate nature of wood dust also may contribute to wood dust-associated carcinogenesis, because dust generated by woodworking typically consists of a high proportion of particles that are deposited in the nasal cavity. Some studies of people with long-term exposure to wood dust have found decreased mucociliary clearance and enhanced inflammatory reactions in the nasal cavity, following by Maatta *et al* 's study in 2006 (Määttä, Lehto et al. 2006). The studied of wood dust particle induces pulmonary inflammation in mice to identify the mechanisms by which lung diseases develop. They used oak and birch, created fine dusts with 90 % 5nm or less, and used titanium dioxide as a control dust, instilled intranasally 2 week for 3 weeks, and then airway hyper reactivity to methacholine was measured by body plethysmography. The mice were then killed and blood, bronchial alveolar lavage fluids and tissue samples were taken. The results showed that repeated exposure to he oak and birch dusts caused influx of inflammatory cells into the lungs, and on a molecular level was associated with increase in several cytokines, chemokines and chemokine receptors in the lung tissue. There is inadequate evidence for the carcinogenicity of wood dust from studies in experimental animals. However, each of these studies suffers from various limitations; such as small numbers of animals or dose groups, short study duration, or inadequate data reporting. The studied wood dust particle induces pulmonary inflammation in mice to identify the mechanisms by which lung diseases develop.

As like the Pylkkänen *et al*. studied in Finland 2009, The study used dust from pine, birch and oak, generated dusts with 90 percent less than 5 um, and exposed human bronchial epithelial cells from The American Type Culture Collection in 3 concentrations (10, 50, & 500 um/ml and 5 duration periods from 0.5-24hr. All wood dusts caused cytotoxicity, dose dependent and statistically significant at 2 and 6 hrs. Exposure to all three woods stimulated reactive oxygen species (ROS) and induced capase-3 protease activity (Pylkkänen, Stockmann-Juvala et al. 2009). The later studied, in 2009 by Pukkala *et al*. had analyzed to cancer and occupation from the extensive registries in the Scandinavian countries revealed a high RR for sino-nasal cancer and wood trades. Finnish Cancer Registry evaluated records of 15 million people aged 30-64 years and the 2.8 million incident cancers diagnosed in them through the personal identity code linkage system used in all the Nordic countries. The results are presented as "Standardized Incidence Ratio-SIR" the number of cases observed divided by the expected number. Occupations were grouped into 53 active and one group of economically inactive folks. "Wood workers "were one of the 53 codes. For nasal adenocarcinoma in male wood workers, the SIR was 5.50(4.60-6.56) (Pukkala, Martinsen et al. 2009).

2.5.5. Chemicals Exposures

Wood often contains exogenous chemicals applied in the course of its processing. These include adhesive, solvents, resin, binders, insecticides and fungicides, waterproofing compounds, paints and pigments, lacquers and vanishes. Many of these are volatile and may be emitted when the wood is treated, heats or incinerated; they are also conveyed as elements in wood dust. The most important of these include, toluene, methanol, xylene, methyl, ethyl, ketone, *n*-butyl alcohol, 1, 1, 1-trichlorethane and dichloromethane, many of which are known or suspected carcinogens. (EPA., 1995.)

The previous studied involved chemical substances in wood dust were few reported (Hagström, Axelsson et al. 2008). They studied to airborne substances exposure that are potentially harmful to health during the production of wood pellets, including wood dust, monoterpenes, and resin acids, and as an indicator of diesel exhaust nitrogen dioxide. In addition, area measurements were taken to assess background exposure levels of these substances, volatile organic compounds (VOCs), and carbon monoxide. Measurements were taken at four wood pellet production plants from May 2004 to April 2005. Forty-four workers participated in the study, and a total of 68 personal measurements were taken to determine personal exposure to wood dust (inhalable and total dust), resin acids, monoterpenes, and nitrogen dioxide. Personal exposure levels to wood dust were high, and a third of the measured levels of inhalable dust exceeded the Swedish occupational exposure limit (OEL) of 2 mg/m3. Parallel measurements of inhalable and total dust indicated that the former were, on average, 3.2 times higher than the latter. The data indicate that workers at the plants are exposed to significant amounts of the resin acid 7-oxodehydroabietic acid in the air, an observation that has not been recorded previously at wood processing and handling plants. The study also found evidence of exposure to dehydroabietic acid, and exposure levels for resin acids approached 74 percent of the British OEL for colophony, set at 50 microgrum/m3. Personal exposure levels to monoterpenes and nitrogen dioxide were low. Area sampling measurements indicated that aldehydes and terpenes were the most abundant VOCs, suggesting that measuring personal exposure to aldehydes might be of interest. Carbon monoxide levels were under the detection limit in all area measurements. High wood dust exposure levels are likely to have implications for worker health; therefore, it is important to reduce exposure to wood dust in this industry.

Some studies have referred to products containing chemical fragrance such as air fresheners, fragranced candles and incenses, cosmetics, wood furniture, and other household products. Fragrance is increasingly cited as a trigger in health conditions such as asthma, allergies and migraine headaches. In addition, some fragrance materials have been found to accumulate in adipose tissue and are present in breast milk. Other materials are suspected of being hormone disruptors. Fragrances are volatile compounds, which add to both indoor and outdoor air pollution. Synthetic musk compounds are persistent in the environment and contaminate waterways and aquatic wildlife (Bridges 2002).

Currently, the chemical in group of aromatic compound were used in many industries and mixed in products for fragrances scented. The fragrances may cause allergic reactions, headache, nauseas, confuses, and defect to neurological sign. and some workers are unable to work in the factory because of this effect.

2.6 Study in Thailand

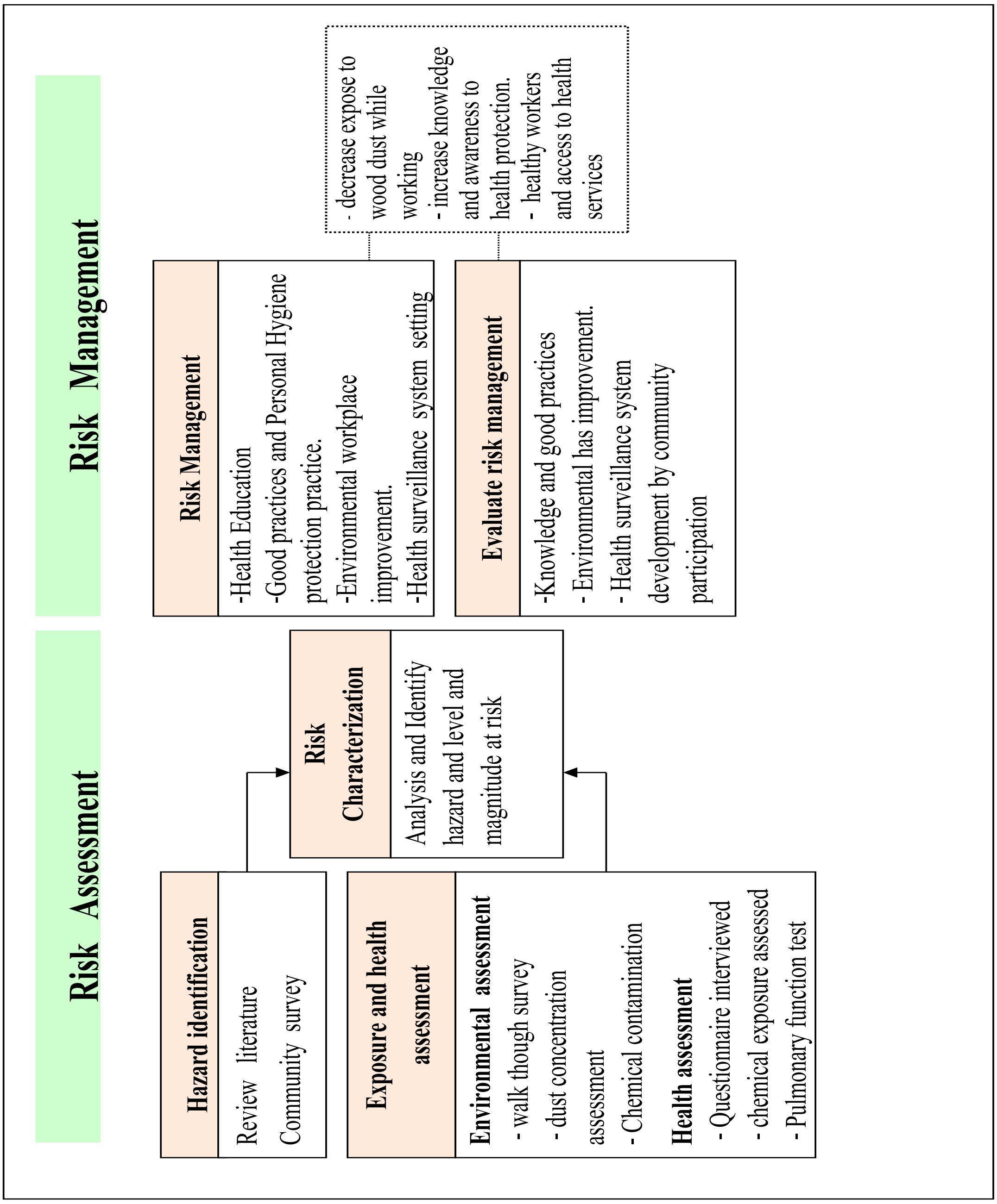
The study health related to wood dust exposure in Thailand are few studies. In 1996, Regional Health Promotion Center the forth, Rajburi Province, Thailand had studied hazard in workplace and evaluated health risk about respiratory system by random sampling 265 workers in 13 factories that exposed to wood dust. The results showed that workers have malaise 32.8 percent, sneezing 23.8 percent, cough and chest tightness 15.1 percent, irritant eyes and conjunctivitis 17.0 percent, most of workers have more than one year and severed until to treatment with medicine 49 percent and when stop working or resting, the symptoms get well 53.8 percent. For spirometer, workers have abnormal 33.2 percent, type of abnormal were mild and moderate restrictive. While The studied of National Institute for the Improvement of Working Condition and Environment, Ministry of Labors, Thailand to study work environment and occupational disease surveillance in saw mill, wood transformation, wood manufacture and wood products. Showed the result to prevalence rate of work related symptoms as 79.58 percent, most of symptoms were headache (66.9%) and cough (50.3%). Workers had abnormal pulmonary function test 12.5 percent, restrictive type 61.7 percent, and obstructive type 33.3 percent and combined type (5%), respectively. (MOL.,2000). As Suwit Numpa studied of 200 plywood processing workers in Samutprakarn Province. Found the mean concentrations of respirable dust in the three studied groups were significant different at p-value < 0.05. Workers have obstructive type 35.9 percent, restrictive type 47.8 percent and combined type 16.3 percent. For comparison factors among normal and abnormal pulmonary function groups, it was found age, duration of work, weight and height were statistically different at p-value <0.05 related with FEV_1 and $FEF_{25-75\%}$.(Suwit, 2002). There is the same the cross sectional study as Sompratana,2005, the study to prevalence rate and factors associated with symptoms and abnormal pulmonary function, there was conducted among 120 workers who worked in furniture factory and devised in 5 group types of work. The study found that the highest average concentration of respirable dust was 0.59 mg/m3 in sanding section and concentration of toluene was 9.02 ppm. in areas and 10.07 ppm. In personal sampling. Cutting section had the highest prevalence rate of symptom (94.3%) of which headache and itching, abnormal pulmonary function was objective type 10 %, restrictive type 90%. The factors associated with symptom showed that a significant symptom associated with respiratory illness was allergy, cough, wheezing, and nose irritation, block nose and skin irritation (WORKERS 2005). The later studied, Sripaiboonkij *et al*, They had studied to rubber tree dust exposure to respiratory and skin symptoms, asthma and lung function. There are 103 workers in a rubber tree furniture factory and 76 office workers in four factories in Thailand. The results showed increased risk of wheezing, nasal symptoms and asthma. There was a dose-dependent increase in wheeze and skin symptoms in relation to dust level. Significantly increased risks of nasal symptoms (adj OR 3.67, 95% CL 1.45-9.28) and asthma (OR: 8.41, 95% CL 1.06 to 66.60) were detected in the low exposure category. The dose-dependent reduction with wood dust level in spirometric lung function (Sripaiboonkij, Phanprasit et al. 2009).

The previous studied to wood exposure, Most were conducted in the wood factory such as furniture factory, plywood, sawmill and others. There are few studies to wood dust exposure in another products such as incense manufacturing, wood powder factory. The only study to identify health hazards associated with wood dust exposure have been investigated wood dust exposure levels and pulmonary effects among joss stick workers in Taiwan, 1996 by Saou-Hsing Lion *et al (Lion, Yang et al. 1996)*. Greater dust concentrations, as measured by six-stage cascade impacts were observed in work areas where joss sticks were produced and incense was mixed than in other work areas. Total dust concentrations for these two high dust activities ranged from 9.9 to 42.7 mg/m^3, and respirable proportions were between 2.0 and 54.6 percent. Higher dust levels were observed for dry joss stick production methods than for wet production methods. Dust levels for all other performance areas were lower than the permissible exposure level of 10 mg/m^3. Although symptoms of cough and phlegm were higher in smoking workers than in non-smoking workers, the prevalence of respiratory symptoms for exposed workers was not significantly higher than for the controls. The prevalence of pulmonary function deficits and the values of $FEF_{25\%}$ and $FEF_{75\%}$ in the exposed workers were significantly worse than those in the controls. But no difference was found between the male controls and the male exposed workers, the high-exposure group. Respiratory symptoms and pulmonary function also did not show a dose-response trend with the exposure levels estimated by correlation with worker job titles and duration of employment. No suspected case of pneumoconiosis was found from the chest radiographs. These results suggest that wood dust exposure in the joss stick industries might not lead to significant pulmonary damage (Lion, Yang et al. 1996).

In Thailand, many manufacturing are removed to community around country such as sewing, artificial flower, footwear, furniture, food products and others Incense and joss stick making is one of products which have made from villages. The products have used several materials in production process, some material may effected to health such as chemical, organic and inorganic dust and physical hazard may occurred while working. This project is the first study in Thailand to study the health effects associate with wood dust exposure among incense and joss stick maker in the villages. The most incense and joss stick products from the villages are manually manufacturing. The health effects will occur from expose to wood dust and chemical by unsafe making process such as without wearing personal protection equipment (PPE), unsafe workplace, inappropriate working behaviors etc.

The significant of the study will identify the risk factors and health effects as may be resulting from exposure with hazards in occupational. The results of the study will be used to improve the making process, workplace and modify health surveillance and health care system among workers who are working in the community.

Figure 7 Conceptual Framework for



CHAPTER III
RESEARCH METHODOLOGY

The study was divided into 2 phrases; the first phrase was cross sectional study by walkthrough survey and observation for environmental workplace assessment. The second phrase was retrospective cohort study for evaluation health risk and health effect comparative between incense workers and non- incense workers. And all phrases were conducted as following:

Phrase 1: Environmental workplace assessment hazard Identification by:

-The walk-through survey and observation for assessment the environmental workplace, studied the incense and joss stick making process, PPE using, and waste and residue management observation

- Dust and particle concentration measurement in environmental workplace and household factory

- Chemical concentration assessment in dissolved dyeing and incense and joss stick products

- Identify of the hazards in workplace and household factory

Phrase 2 : Health risk assessment

- The Questionnaires interviewed for health risk and health effects evaluation and incense workers and non- incense workers

- Pulmonary function deficit testing for evaluation health impacts related to wood dust and chemical exposure comparative between incense workers and non- incense workers.

- Chemical exposure assessment for evaluation the risk associated with chemical exposure.

3.1 Research Design

The research design of this study were used in two phrase of study the first was cross sectional study for environment workplace assessment by walkthrough survey in the household factory, evaluated dust and small particle and chemical concentration. The second phrase was used a retrospective cohort study for health risk assessment with by face to face questionnaire interview comparative between exposure and non - exposure group. The pulmonary function testing and chemical exposure assessment were done in the second phrase.

3.2 Sample and Sampling method

3.2.1 Sample and Sampling method in Phrase 1: environmental workplace assessment hazard identification

Dond Deang subdistrict, Roi-et province, is the largest areas for incense and joss stick making and was purposively selected as the areas of the study site. There are total 12 villages in sub district and incense productions were produced in 10 villages. Almost of all persons in household were incense workers and around 95 households were designed to small factories for incense making. The samples size were selected to the phrase 1 as in Figure 3.2. There were 21 households factories selected for walkthrough survey, 4 household factories for evaluation dust and small particle concentration and 10 incense products and 10 samples of dissolved dyeing for chemical testing were selected from small household factories.

3.2.2 Sample and Sampling method in Phrase 2: Health risk assessment

3.2.2.1 The sample selected for retrospective cohort for health assessment

The sample size for retrospective cohort was calculated based on a result from previous a meta-analysis on wood dust exposure and risk of asthma and respiratory symptoms study(Pérez-Ríos, Ruano-Ravina et al. 2010). The study indicated that the pooled RR was 1.53 (95% CI 1.25-1.87) and the sample size calculation were used software, EPI info 2002 and which as formula for sample size calculating on cohort and cross sectional study. By providing level for calculation; probability that if the two samples differ this reflect a true difference in the two population are confidence level at 95%, power 80%. Ratio between number of unexposed and number of exposed are 1:1, Expected frequency of diseases in unexposed group is 44.5 %* (* The proportion of morbidity of respiratory tract in outpatient, Public health statistic .2008), MOPH and RR = 1.5 (Pérez-Ríos, Ruano-Ravina et al. 2010).

The sample sizes form calculation was 184 samples and there will be added the adjusting for potential dropout 10 %. A total of sample sizes are 184 and 8.8 participants (estimate to 10 participants) included. Hence, the sample sizes of the study will be 193 selected. The subject will be assigned to unexposed and number of exposed group by ratio 1:1. So there are 96 subjects in each group.(Figure 3.3)

The formula for the cross-sectional analytic study calculation the sample size is as follows:

$$N = [\ Z\alpha \sqrt{2pq} + Z\beta\sqrt{p1q1 + p0q0}]2/$$

$$[p1 - p0]2$$

N = the number of exposed individuals

$Z\alpha$ = Z value from normal standard distribution when assign

Type 1 error = 5% (α = 95%)

$Z\beta$ = Z value from normal distribution standard when assign

Type 2 error = 20% (1-β = 80% (power)

P0 = the proportion of unexposed individual who develop the disease

(44.5% morbidity of respiratory, public health statistic 2008)

P1 = the proportion of exposed individuals who develop the disease

$$P1 = P0 \times R / [1+P0(R-1)]$$

R = the ration of the number of unexposed individual studied to the number of exposed individuals studied) RR=1.5 (Pérez-Ríos, Ruano-Ravina et al. 2010).

The random sampling was used for selection the exposure group in ten villages. There are around 412 persons who incense and joss stick manufacturing.(Data survey, 2009). The purposive sampling uses for selecting the village and the two villages, 5^{th} and 12^{th} village were selected because there were the large areas for incense making. The participants were selected by the simple random technic.

3.2.2.2 The sample selected for chemical exposure evaluation

The random sampling was used for selection the participant for chemical evaluation by purposive selected among incense workers and non - incense workers. There were 25 samples selected in each group, the incense workers who made incense in all the process of incense making such as mixing, rolling and shaking, dipping dyeing, and drying, were selected samples.

Inclusion and Exclusion groups of the study

Inclusion criteria:

Exposure group: They must have been current making incense and joss stick in the 5th and 12th village at least 1 year, both male and female with more than 15 years old and informed consent for the participants who are willing to be participant in this study.

Non- Exposure group: They must have been in the 4th and 10th village at least 1 year, both male and female with more than 15 years old and informed consent for the participants who are willing to be participant in this study.

Exclusion criteria:

Exposure group: The participants were excluded from this study which had duration of work less than one year and less than 15 years old. And they had serious illness and did not willing to be participant.

Non- Exposure group: The participants were excluded from this study which had lived in the villages less than one year and less than 15 years old. The participants who had serious illness and did not willing to be participant were excluded.

3.3 Study Area

Dong Deang sub-district, Roe-et province, the sub-district is the largest area where is making incense and joss stick in Thailand. The sub-district comprises 12 villages, 2,182 household, 7,800 residents.

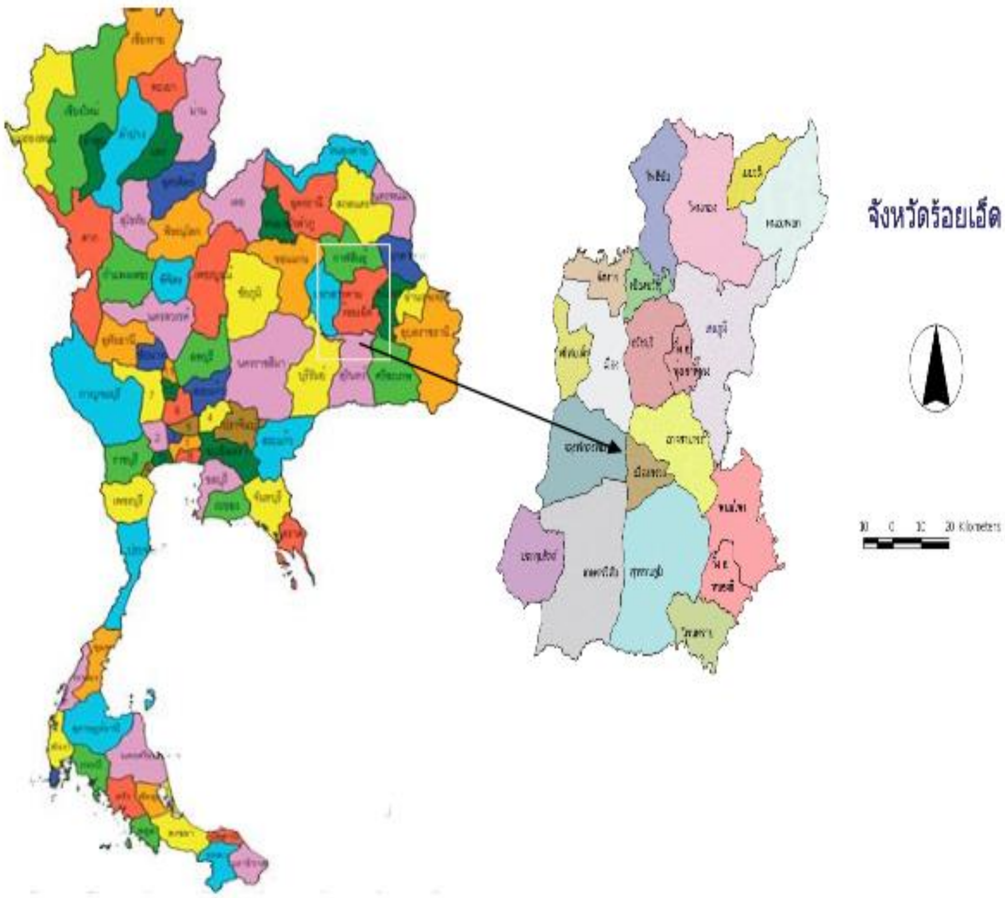


Figure 8 Map of Roi-et province and study area

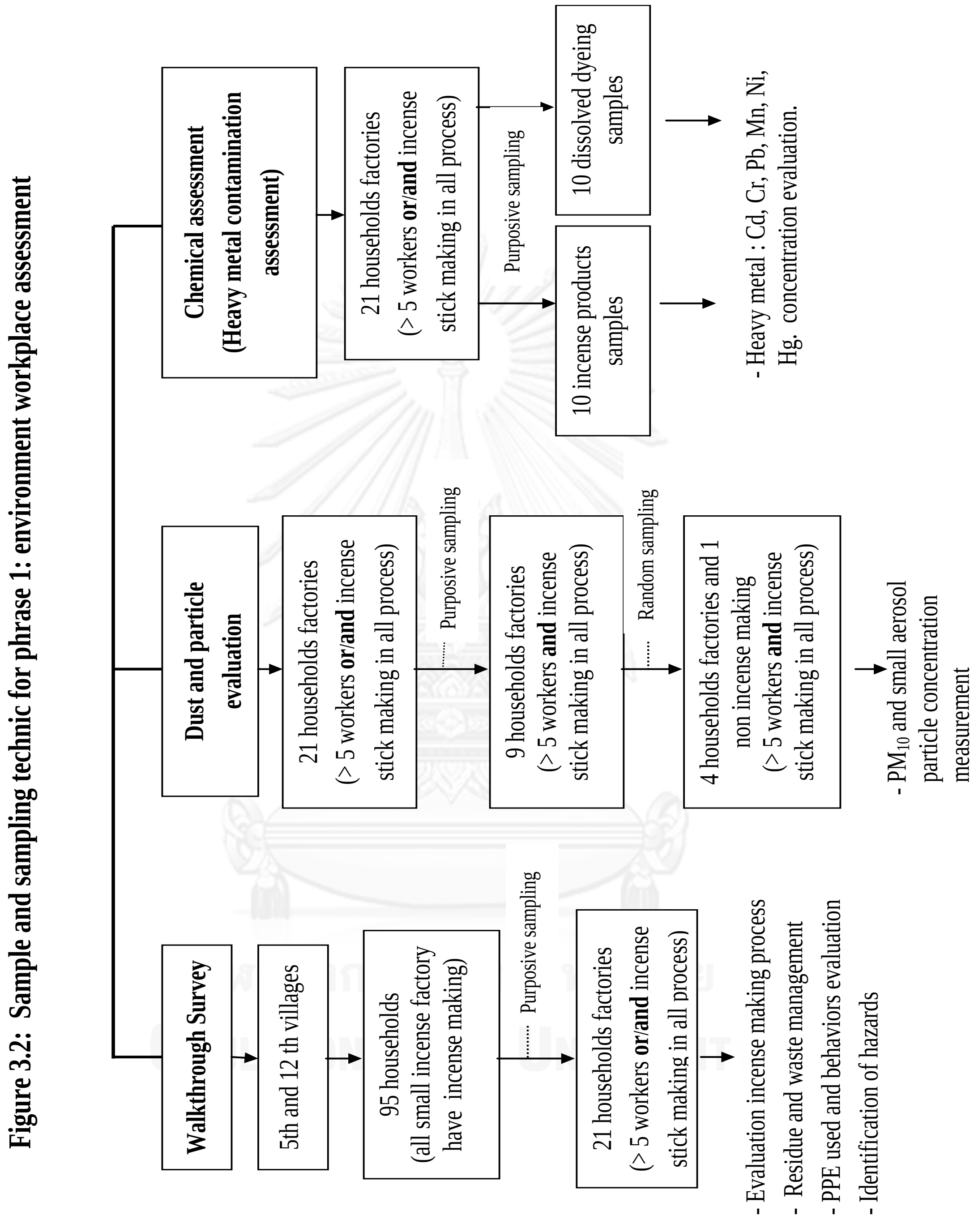
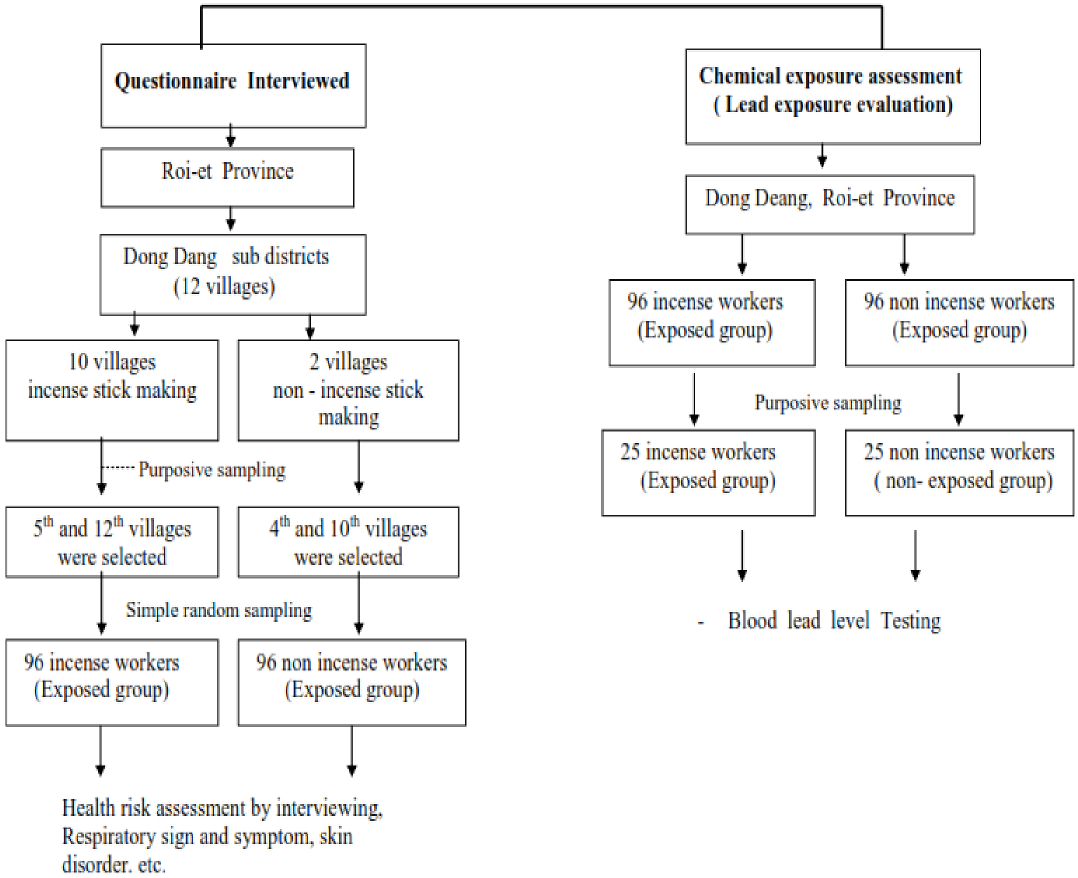


Figure 9 Sample and sampling technic for phrase 1: environment workplace assessment

Figure 10 Sample and sampling technic for phrase 2: Health risk assessment



3. 4 Research protocol

The study was used conception of health risk assessment for identify hazard and health risk and health effects which related to occupational health among incense workers. This study was divided 2 phrases as follow: **Phrase 1**: Environmental workplace assessment and hazard identification by:

The walkthrough survey is a technical review of operations, workers, material in process production used to more clearly identify potential health hazards and help guide a quantitative health assessment. The stages of walk through survey will estimate the hazard requires to the study. Environment, health, and safety assessment will conduct a walk through survey by researcher and team members such as local authority, staffs of community health center, health volunteers and workers etc.. The walk through survey were used the record form was adopt from the Canada Occupational Walkthrough survey form environmental evaluation which consist in the main information such as the nature of process operation, material and quantities used, equipment and machinery, identified hazards, personal protective equipment (PPE) used, waste and environmental management, etc.

- Dust and particle concentration measurement in environmental workplace and household factory. The household factories selected by criteria were measured dust (PM_{10}) and aerosol particle in real time by staff of Division of Medical Engineering (DME), Ministry of Public health (MoPH) who have experience for measurement. Due to the time constraints and ability to representdata. Therefore, the only four small household factories were purposive selected sampling for the real time aerosol and particle concentration measurement which each have making all incense and joss stick making process

- Chemical concentration assessment in dissolved dyeing and incense and joss stick products. Since in process of incense making had used many raw material and chemical especially inequality color for incense dyeing, therefore, the study evaluated to chemical contamination in products and residue dyeing.

- Identify of the hazards in workplace household factory. The study identified the hazards in household factory after collecting data from walkthrough survey, dust and particle concentration measured, Chemical concentration testing.

Phrase 2 : Health risk assessment

The interview were actuated to participant both non exposure and exposure group who make incense products. The questionnaire was applied for data recording include work history, health behavior, respiratory illness and others. The variable in questionnaire were analyzed and evaluated to relationship between cause and health effects. The questionnaire were considered by 3 experts and interviewer are researchers team include staff of ministry of public health, staff of provincial and district hospital. They were trained before leading to collecting data. -

The Questionnaires interviewed for health risk and health effects evaluation and incense workers and non- incense workers. Before interviewed, building team face to face interviewers, The team comprises of technical public health, nurse who worked at health promotion hospital, district hospital and bureau of epidemiology, they were trained and informed to understand the purposive of the study and questionnaire interviewed.

- Pulmonary function deficit testing for evaluation health impacts related to wood dust and chemical exposure comparative between incense workers and non- incense workers. The pulmonary function test (PFT) were conducted by occupational nurse in Roi-et hospital who has experience for spirometry and pulmonary function test. The participants among incense workers and non-incense workers were prepared and informed to objective and understand for PFT before testing.

- Chemical exposure assessment for evaluation the risk associated with chemical exposure. Blood lead testing was used for chemical contaminated evaluation, The blood for lead testing were collected by nurse in district hospital and the blood were sent to laboratory room of Bureau of Occupational and Environmental, MopH. Before blood lead testing, the participants were informed to purposive of the study and chemical testing.

3.5 Research instruments

3.5.1 Questionnaire interviews

The collecting data in the steps of the part of exposure assessment were face to face interviewed by using questionnaire record. The questionnaire had applied from several unit such as Occupational and Environmental Disease Unit, University of British Columbia and The America association for Thoracic, divided into 5 parts:

Part I: General information. The part was included as the following information ; gender, age, marital status, educational level, occupational and function, income and about family etc.

Part II : Occupational history: The part wasdetermined and record history of work among incense and joss stick workers and duration of incense making. Which the work as the subject has worked in record on lines the number of years in which the subject has worked any all in industries and others. This part was supporting and refer to the risk factors from previous work..

Part III: Health behavior The variables in this part included the items for smoking, drinking and wearing PPE. Smoking is important information in this part because it was identified and relate to respiratory syndromes and affected to occupational health. The information PPE was used to evaluation and implement to good practices in working.

Part IV: Past illness history. This part was collected history of illness data which related to health effects from occupational or other sources. The data was indicated to the previous illness of the subjects included injury or operation, heart diseases, bronchitis, pneumonia, bronchial asthma, and other chest trouble etc.

Part V: Acute and current symptoms. The part of questionnaire was collected a significant sign and symptoms which due to occupational exposure. The respiratory symptoms are important in the study because the symptoms relate to wood dust exposure. The sign and symptoms as relate to dust exposure include cough, phlegm, breathlessness, wheezing, nasal drainage, chest illness and asthma etc. The current illness information will be used to assess health condition in workers. The current sign and symptoms were explained the relationship between duration of work and symptom in occupational health assessment.

For understanding in objective, the way for data collection and a query of the questionnaire. The data collecting by questionnaire was conducted after the interviewers training. The interviewers were around ten of the staffs from local and provincial health center and Bureau of Epidemiology, MopH. The interviewers were trained before interview and record the data.

3.5.2. *Pulmonary Function Test*

The spirometry test requires the patient to make a maximal inspiratory and expiratory effort. The patient in a sitting or standing position breathes into mouthpieces and nose clips are places a prevent air leak. To obtain interpretable results form spirometry, it is essential that the patient give full effort during testing. Spirometry will be measurement include:

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

2. Forced expiratory volume in one second (FEV_1) : is the maximal volume of air exhaled in the first second of forced expiration from a position of full inspiration expressed in litres at BTPS (Body temperature and pressure, saturated)

3. Forced Expiratory Volume1 / Forced vital capacity Ratio (FEV_1/FVC): The FEV_1 expressed as a percentage of FVC and give a clinically useful index of airflow limitation.The FEV_1/FVC ratio is used as a broad indicator of airway obstruction.

4. Forced Expiratory $flow_{25-75\%}$. ($FEF_{25-75\%}$)**:** The mean forced expiratory flow between 25% and 75% of FVC. $FEF_{25-75\%}$ has also been known as the maximum mid expiratory flow. The normal 25-75% in the average healthy male between 25 and 30 years old about 4.5 L/sec. The normal FEF 25-75% in the average healthy female between 20 and 30 years old is about 3.5 L/sec. The $FEF_{25-75\%}$ progressively decrease in obstruction disease and with age (Pellegrino, Rodarte et al. 1998, Miller, Atkins et al. 2003).

Predicted normal values

Predicted normal values for pulmonary function generally vary as following:

1. Age: FEV_1,FVC, $FEF_{25-75\%}$and PEF increase, while FEV_1, FVC% decreases, with age until about 20 years old in females and 25 years in males.

2. Gender : 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%.

3. Height : All indices other than FEV_1,FVC% increase with standing height.

Pulmonary function tests were performed at the worksite using Pony graphic spirometer (COSMED, Sri - Italy).were used to standardized tests of FVC, FEV_1/FVC% and $FEF_{25-75\%}$. Among 96 incense workers and 96 non incense workers and pulmonary function test was conducted by occupational nurse from Roi-Et hospital Pulmonary function Test (PFT) will be tested after the workers worked at least 2 hours. The parameters collected are FVC, FEV_1/FVC% and $FEF_{25-75\%}$. The results were interpreted the predicted normal values from the reference spirometric values for healthy lifetime nonsmokers in Thailand from Siriraj Hospital. (*Dejsomritrutai W, Nana A,Maranetra KN.et al*) 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 these study should be convincible. Thus, in these study will be used Siriraj equation in calculating the predicted normal values, for interpret pulmonary function test of sample size. (Dejsomritrutai, and Maranetra .et al, 2000.)

The procedures for PFT are following :

The subject's age, gender, and race are recorded, and height and weight are measured before the procedure begins. The subjects should not have eaten heavily within three hours of the test and should not smoke and drink alcohol for 24 hours before the test. He or she should be instructed to wear loose-fitting clothing over the chest and abdominal area. The respiratory therapist or other testing personnel should explain and demonstrate the breathing maneuvers to the subjects The subjects should practice breathing into the mouthpiece until he or she is able to duplicate the maneuvers successfully on two consecutive attempts. The test repeated at least three acceptable maneuvers should be obtain and recorded the best values.

3.5.3. Dust and aerosol particle measurement

A tool for a real time exposure monitoring measured aerosol and particles concentration corresponding to PM^{10} using Dusttrak aerosol monitor 8520 (Dust Trak™ -

measured concentration in mg/m^3) and detected small particles and particles of chemical reaction by Ultrafine Particle Counter 8525(P-Trak™ - measured concentration in $particles/cm^2$) Calculated and monitoring by Division of Medical Engineering (DME), Ministry of Public health (MoPH). The real time dust evaluation for environmental workplace assessment comparative between the house which has incense factory and without incense factory. Due to the time constraints and ability to representdata. Therefore, the only four small household factories were purposive selected sampling for the real time aerosol and particle concentration measurement which each have making all incense and joss stick making process.

3.5.4 Chemical contaminated testing

The method for evaluation of chemical contamination was the microwave digestion method and analysis by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) was used for heavy metal testing in dissolve dyeing of incenses and incense products. Many chemicals such as barium, manganese, lead, cadmium, chromium and nickel were tested in ten dissolved dyeing and ten incense products samples.

3.5.5 Blood lead level testing

The blood lead level was collected and analyzed for lead exposure assessment by Graphite Furnace Atomic Absorption Spectrophotometry methods and reference toxicology Laboratory center, Bureau of Occupational and Environmental diseases,, Ministry of Public Health. The testing was conducted and evaluation among incense workers and non-incense workers.

3.5.6 The record form for walkthrough survey

The equipment used for data collecting by the walk-through. survey record form was adopt from the Canada Occupational Walkthrough survey form which consist in the main information such as the nature of process operation, material and quantities used, equipment and machinery, identified hazards, personal protective equipment (PPE) used, waste and environmental management, etc.

3.6 Data collection

Quantitative Data collection of the study was collection by as following :

- The data of questionnaire interview were collected for respiratory sign and symptom evaluation in both group, among incense workers and non- incense workers (non-exposure group)
- The data of dust and aerosol particle assessment were collected by the real time dust and aerosol measurement in all of the incense making process.
- The Chemical contaminated assessment were collected the data by heavy metal testing in incense products and residue dyeing by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method.
- The blood lead level was the data for chemical exposure evaluation and were collected in both group among incense workers and non- incense workers (non- exposure group) by Graphite Furnace Atomic Absorption Spectrophotometry methods

3.7 Data analysis

The data of the study was analyzed following the outcome by descriptive and analytical analysis. Demographic characteristic of the participants were described by mean, standard deviation for continuous variables and the categorical variables were described by frequency and percentages. There were compared socio-demographic, characteristics, PFT measurement, and sign and symptoms among two groups of workers (non-exposure and exposure) by using one way analysis of variance (ANOVA), t-test, chi square and fisher exact analysis for statistic significance (α at 0.05) for both continuous and categorical variable. Odd ratios and 95% confidence internal for coefficients.

3.8 Study Period

Figure 11 Time line of study procedure

Prepared study		Phrase 1: Environmental workplace assessment			Phrase 2: Health risk assessment			Final study
Proposal examination Passed	Ethics committee passed	Walkthrough survey for workplace assessment	Dust and particle assessment	Chemical contamination evaluation	Questionnaire interviewed	Pulmonary function testing	Blood lead level testing	Analyzed and summary report
- Review literature - Developed tool - established team for study		Selected factory/ Collected data	Collaborate team/ prepared tool / collected data	Collaborate team/ prepared tool / collected data	Developed Questionnaire/ Collaborate and trained for interview team// collected data	Collaborated team/ informed to participants / Collected data	Collaborated team/ informed to participants / Collected data	
Jan-April 2011		Oct 2011	Dec 2011	Feb 2012	Feb 2012	April 2012	May2012	2013

CHAPTER IV
RESULTS

The results of this study are presented for two phrases. The first phrase was cross sectional study for environmental workplace assessment and hazard identification by walkthrough survey and observation, evaluated dust and particle in workplace, chemical concentration assessment and waste and residue management. The second phrase was retrospective cohort study for health risk and effects evaluation by questionnaire interviews, chemical exposure and pulmonary function and comparative with incense workers and non incense workers. The results of the study summarized in to 2 part as following:

Phrase 4.1 Environmental workplace exposure assessment and hazard identification

Phrase 4.2 Health risk and health effects assessment

4.1 Results of phrase 1: Environmental workplace exposure assessment and hazard identification

4.1.1 The walkthrough survey for workplace evaluation

The walkthrough survey is a technical review of environmental workplace assessment. The equipment used for data collecting by the walk-through survey record form were adopt from the Canada Occupational Walkthrough survey form which consist in the main information such as the nature of process operation, material and quantities used, equipment and machinery, identified hazards, personal protective equipment (PPE) used, waste and environmental management, etc. The walkthrough survey was conducted in nine household factories which have developed in all incense making process. The results from the survey showed that as following:

4.1.1.1 The process of incense stick making and raw material

There are two types of incense stick were made in the village such as “Toop *Saad*" (ธูปซัด(and "*Toop Fun*" (ธูปฟั่น), but the most popular product is *“Toop Saad”*. This study has demonstrated only the process of manufacturing incense stick, *Toop Saad* method. The raw material for incense and joss stick making *"Toop Saad"* consist of bamboo stick, glutinous incense power that Thai people call "*Goow bowa*", incenses wood powders, fragrances incense powder (sandalwood), colors powder, perfumes oil and others chemical. (picture 2-7)

picture 2 Bamboo cores

picture 3 Saw dust

picture 4 Glutinous incense

picture 5 Dye colors powder

Picture 6 Perfumes oil

picture 7 Others chemical

The process or procedure was not complicated and not use advanced technology and can make by manual. From the investigation by walkthrough survey shown the simple steps on the process of incense making, which are (1) Bamboo cores preparation, the bamboo cores were used for incense sticks. (2) Mixing different incense powders such as sawdust and glutinous incense powder together in the correct proportion. (3) Rolling and shaking wood powders onto the sticks, immerse a bundle of bamboo stick into the water and rolling the incense wood powders onto the stick. Then, the workers will shake the layered sticks to remove loose powders. Repeated as incense wood powders are firmly rolled on the sticks layer by layer until desirable size and leading the sticks to drying under the sun. (4) Dipping into an incense colors and dying stick, after drying a worker will collect incense and joss sticks for dying with incense colors, the red and yellow paint are popular used for incense dying. Then the dyed sticks are spread out once again under the sun for drying. (5) Spraying aromatic perfume and packaging (6) Preparation to distribute. After the incense and joss sticks products are dried, some may be sprayed with perfumes oil before packing. (Figure 2)

Most of incense and joss sticks are products from household factory. There are usually made manually and not used many equipment and machine. Only a few workers can make all incense making process. Almost of all the steps were made by male workers such as mixing different incense powders, rolling and shaking wood powders, colors dying stick and spraying aromatic perfume. And female usually do in the process of wrapping and packing, some has made spraying aromatic perfume on incense and joss stick products Most of bamboo core for incense stick was prepared by cutting and sharpening machine and only a few small household factories which prepared bamboo core sticks by hand. Furthermore, incense and joss sticks production must have enough widely areas for drying incense sticks. Therefore, the incense sticks were generally made in the village during summer and winter season.

Figure 12 The process of incense stick making, "*Toop Saad*" method

4.1.1.2 Dust and particles concentration assessment

The walk-through survey in the nine factories, six small factories produced incense and joss stick in house and other three factories separated and located away from their house around 10-50 meters. Dust is the major hazards from the incense making process and spread around the house include bedroom and cooking area. Dust and particles concentration were measured in real time exposure monitoring for dust concentration identification. A tool for a real time exposure monitoring measured aerosol and particles concentration corresponding to PM^{10} by Division of Medical Engineering (DME), Ministry of Public health (MoPH), using Dusttrak aerosol monitor 8520 (Dust Trak™ - measured concentration in mg/m^3) and detected small particles and particles of chemical reaction by Ultrafine Particle Counter 8525(P-Trak™ - measured concentration in $particles/cm^2$) for environmental assessment at workplace and comparative between the house which has incense factory and without incense factory. Due to the time constraints and ability to represent data therefore the only four small household factories were purposive selected sampling for the real time aerosol and particle concentration measurement which each have making all incense and joss stick making process. The dust and small particles were measured and repeated in three times every ten minutes in each process. Results from Table 4.1 showed that the dust (particulate matter 10 micron. PM_{10}) concentrations were high in all the production process especially in stage of rolling and shaking wood powders onto the sticks, packaging and mixing process, an average dust concentration in the stages were 0.538 ± 0.27 mg/m3 0.475 ± 0.16 mg/m3 and 0.314±.17 mg/m3, respectively. The raw materials used in incenses making contain with chemicals such as heavy metal and aerosol substances as are components of dye color and perfumes. The small aerosol particles count measurement was identify chemical reaction particles in environmental workplace. The study shown that amount average mean of small aerosol particles was the highest in the process of aromatics spraying and packing. There were 9,018.0 PT/cc in aromatics spraying process and in the stage of packing were 8,602.5 PT/cc. The measurement found that dust concentration in the house without factory was only 0.023±.25 (mg/m^3) and small particle count 1,465.0±21 PT/CC. The dust level and small particles count in the small household factories were higher than the house without factories.

Table 4.1: The real time measurement for Dust (PM_{10}) concentration in incense and joss stick making, in small household factory, Roi-et, Thailand.

Table 4.1: The real time measurement for Dust (PM_{10}) concentration in incense and joss stick making, in small household factory, Roi-et, Thailand

Incense making process	Dust Concentration(PM_{10}) (mg/m^3)		small aerosol particle count (PT/CC)		Temp (C°)	Humidity	Time
	Mean(Min-Max) (mg/m^3)	**Average mean (mg/m^3 ± SD)**	**mean(Min-Max) (PT/CC)**	**Average mean (PT/CC± SD))**			
Mixing different incense powder (n=12)							
- factory 1 (n=3)	0.140 (0.040-0.331)		1,900.0 (1,750 - 2,030)		30	53	10.00
- factory 2 (n=3)	0.230 (0.060-0.350)	0.314±.17	4,930.0 (4,870 - 4,980)	2,960.0±47	32	44	10.00
- factory 3 (n=3)	0.330 (0.050-0.480)		2,350.0 (2,150 - 2,480)		32	45	11.00
- factory 4 (n=3)	0.550 (0.150-0.840)		3,050.0 (2,880 - 3,320)		33	49	11.00
Rolling and shaking (n=12)							
- factory 1 (n=3)	0.931 (0.040 -2.510)		2,380.0 (2,290 - 2,480)		30	51	10.30
- factory 2 (n=3)	0.430 (0.410- 0.450)	0.538±.26	2,740.0 (2,670 - 2,840)	2,482.5±34	32	43	10.30
- factory 3 (n=3)	0.461 (0.400- 0.510)		2,370.0 (2,320 - 2,440)		33	49	11.30
- factory 4 (n=3)	0.350 (0.300- 0.410)		2,460.0 (2,380 - 2,550)		33	50	11.30
Aromatics spraying (n-=12)							
- factory 1 (n=3)	0.038 (0.033- 0.040)		4,170.0 (4,060 - 4,270)		31	47	11.00
- factory 2 (n=3)	0.170 (0.090- 0.150)	0.134±.07	19,600.0 (18,980 - 20,040)	9,018.0±68	32	44	11.00
- factory 3 (n=3)	0.180 (0.050- 0.260)		4,900.0 (4,720 - 5,140)		32	49	12.00
- factory 4 (n=3)	0.140 (0.040- 0.158)		7,400.0 (7,320 - 7,500)		33	51	12.00
Packing and wrapping (n=12)							
- factory 1 (n=3)	1.530 (0.039- 2.451)		4,170.0 (4,130 - 4,220)		31	53	11.30
- factory 2 (n=3)	0.627 (0.082- 1.120)	0.475±.16	16,520.0 (16,380 - 16,760)	8,602.5±54	32	44	11.30
- factory 3 (n=3)	0.403 (0.300- 0.500)		5,070.0 (4,910 - 5,220)		33	45	12.30
- factory 4 (n=3)	0.285 (0.035- 0.420)		8,650.0 (8,300 - 9,110)		33	49	12.30
Household without incense making factory (n=4)	0.002- 0.054	0.023±.25	1,465.0 (1,250 - 1,750)	1,465.0±21	28	54	09.50

Note: Ambient air quality standards for particulate matter <10 μm in aerodynamic diameter (PM^{10})
0.12 mg/m^3 (average in 24 hrs.) and 0.05 mg/m^3 (average in 1 year), Pollution control Department, Ministry of Natural Resources and Environment. Thailand.

4.1.1.3 Chemicals contamination assessment

Dye color powder, perfumes oil and others material used in the process of incense and joss stick making may consist of several chemicals such as heavy metal and aerosol substances. Chemicals contained in raw materials and production process were analyzed and evaluated by the microwave digestion method and analysis by Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES). Six heavy metals concentration i.e. barium (Ba), manganese (Mn), lead (Pb), cadmium (Cd), chromium (Cr) and nickel (Ni) were tested in dissolved dye incenses and incense products. (picture 8-11) The ten-dye incenses and ten incense products were selected samples for chemical testing. As shown in Table 4.2. The testing found that heavy metals in dissolved dye with in process of collection such as barium (Br), Manganese (Mn), Lead (Pb) were 1.60±0.15, 1.12±0.01, 0.90±0.05 (mg/L± SD), respectively. The average concentration of those heavy metals in incense sticks with in process of packing was 1.30±0.02, 0.87±0.13, 0.95±0.03 mg/kg, respectively.

picture 8 Color dipping

picture 9 dissolved dye incense

picture 10 incense products

picture 11 incense products for distribution

Table 4.2: Chemical contamination assessment in dissolved dye and incense sticks, in small household factory, Roi Et, Thailand

Chemicals (Heavy metals)	**Dissolved dye** (mg/L± SD) (n=10)	**Incense sticks products** (mg/kg± SD) (n=10)
Barium (Ba)	1.60 ± 0.15	1.30 ± 0.29
Cadmium (Cd)	0.17 ± 0.10	0.08 ± 0.03
Chromium (Cr)	1.34 ± 0.13	0.89 ± 0.10
Manganese (Mn)	1.12 ± 0.01	0.87 ± 0.13
Nickel (Ni)	1.34 ± 0.13	0.99 ± 0.19
Lead (Pb)	0.90 ± 0.05	0.95 ± 0.03

Note: Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) method.

4.1.1.4 Health risk behaviors and personal protective equipment (PPE) using evaluation

The results of walkthrough survey and observation study for health risk behaviors and personal protective equipment (PPE) using during working in small household factories found that as shown in Table 4.3. There were fifty-one workers in the nine factories, forty-one were male (80.4%) and ten were female (19.6%). Mostly male workers would make in the process include mixing ingredients, rolling and shaking, dyeing and drying incense and most of female workers would made in the process of wrapping and packaging. Personal protective equipment is to reduce workers exposure to hazards but we found that only 3.9 percent of female workers have used personal protective equipment (PPE) during working such as masks, and 5.9 percent of cotton gloves and proper clothed with long sleeve shirt and trousers to prevent dust around 74.5 percent. After finished working, there were only 39.2 percent had taken a bath before lunch or dinner as shown in picture 12-17 and Table 4.3. Moreover, some workers took care of their children during working especially female who made on the wrapping and packing process at the workplace or their house. Children may be exposed to hazard by inhalation of chemicals and particulate matters all day.

picture 12-13 working without personal protection equipment (PPE) .

picture 14-15 Working without gloves for skin protection

picture 16-17   Workers did not take a bath and changed clothes before lunch during working

Table 4.3: Health behaviors and personal protection equipment (PPE) used during incense and joss stick making, in small household factory, Roi-Et, Thailand

PPE using and health behaviors	Male (n=41)	Female (n=10)	Total (n-51)
	n (%)	n (%)	n (%)
1. Proper Clothing (long sleeve shirt and trousers)	28 (68.3)	10 (100.0)	38 (74.5)
2. Gloves (cotton gloves)	1 (2.4)	2 (20.0)	3 (5.9)
3. Mask (cotton mask)	0	2 (20.0)	2 (3.9)
4. Hand washing before eat or drink	31 (75.6)	10 100.0)	41(80.4)
5. Bathing before lunch or dinner	16 (39.0)	4 (40.0)	20 (39.2)

4.1.1.5 Raw materials, chemicals and incense products stored

The walkthrough survey found that raw material and chemical used in incense making process and incense stick products for distribution were not appropriately stored where in house or household factories and some were storage in bedroom as picture 18-21 showed in below. The workers and others in family have exposed to residue dust, heavy metal and inhaled aromatics volatile, which contained in sawdust, color powder, perfume oil and incense products all day. In addition, these hazards may have effect to all health of workers and others in family.

picture 18-19 Aromatic substance were stored in house

picture 20-21 Incense stick products for distribution were stored in house and in bed room

4.1.1.6 Working in a poorly ventilated workplace

The survey found that the nine small factories manufacturing have poor ventilation. Most workplace has been designed with a tin thatched roof and plastic sheet for closing the room wall for prevention to dust spreading around the house and expanding to bedroom, kitchen and others or a neighbor's house. The workplace with a covered low roof would have dust collection especially dust as occurrence from the process of mixing powders and rolling and shaking process including the steps of wrapping and packing as found that most workers worked in the storeroom as overcrowded and filled with raw materials, chemical and poor ventilation.

picture 22-23 Working in a poor ventilated workplace

4.1.1.7 Children were cared in household factory

As picture 24 - 25 showed that most women would make in process of wrapping and packing the incense sticks products. Some women would bring their children to the workplace in household factory together and sometimes incense stick products from factory were taken to many houses for wrapping and packing. While during working they would care and feed their children in working areas. Children have potential exposed to dust and hazardous substance which distribution during wrapping and packing the incense sticks in their houses.

picture 24 -25 Childcare in the workplace areas

4.1.1.8 Workplace management and waste disposal management

From assessed environmental in the workplace and evaluated waste management in the nine factories by walk-through survey shown that the major waste and residue which remain from the incense stick making process consist of (1) residue water from rolling and shaking stages, (2) dyeing dissolved and (3) dust or incense powders on the floor and stick on wall and others as showed that as picture 26- 25 in below. Waste water would be left around the house or led to plants watering. Dyeing dissolved were stored in a container without covering and spread around the house and discarded on the ground. In addition, the many factory's owners did not sweep or clean the residue dust which spread down on floor and fixed on the wall. Therefore, children and elders who live in or near factories are high-risk persons and have opportunity exposed to dust and chemicals include heavy metals and aromatic substances.

picture 26- 27 Residue water from rolling and shaking incense powder process.

picture 28 - 29 Dyeing dissolved was released around house.

picture 30 - 31 Dust and incense powders spread on the floor and accumulated on the wall.

4.1.1.9 Hazardous identification and Health risk factor evaluation

From the data by the walkthrough survey and dust and particle measurement and heavy metal testing could identify the hazards in all process of incense making that the preliminary hazardous assessment predicated that wood dust and chemical substances was the major hazard which occurred from incense sticks production process, and heavy metal in low quality color included aromatics substances. The workers who have made in the stages of mixing raw material, rolling and shaking may have exposed to dust from sawdust, incense power and glutinous incense powder. While the incense makers who worked in stage of dyeing and perfumes oil spraying may have opportunity to expose various volatile organics substances. The dust and heavy metal and aromatics substances can be directly affected to health of workers during working; furthermore, working with awkward working posture, repetitive movements may relate to musculoskeletal disorders such as back pain and muscle pain. Besides, working without personal protective equipment (PPE), eating during working or eating at workplace areas and smoking are additional factors to cause of health effects. Working without good practise and good hygiene may cause of illness such as occupational injuries, skin diseases, and respiratory symptoms and others as shown in Table 4.4

Table 4.4: Hazards identification and health risk effects evaluation in small incense and joss sticks household factory, Roi-Et, Thailand

Stages of incense making	Hazards Identification	Risks and health effects
Preparation a bamboo cores for incense stick	Machine and equipment, Working posture	cut wound/ muscle and back pain
Mixing different incense powders together	Wood dust	Respiratory disorder (nasal congestion/runny nose/asthma/ and skin disorder (rash/itchy/dermatitis)
Rolling and shaking wood powders onto the sticks	Wood dust, mold Working posture	Respiratory disorder (nasal congestion/runny nose/asthma/ and skin disorder (rash/itchy/dermatitis)/ muscle ,back and wrist pain

Dipping into an incense colors and dyeing /drying sticks	Wood dust, mold/ Working posture/ chemical(heavy metal) heat	Respiratory disorder (nasal congestion/runny nose/asthma/ and skin disorder (rash/itchy/dermatitis)/ muscle ,back and wrist pain/ Neurological sign (dizziness/faint/ headache, etc.) Heat stroke
Spraying aromatic perfume and packaging	Wood dust, mold/ Working posture/chemical(heavy metal/aromatics compound)	Respiratory disorder (nasal congestion/runny nose/asthma/ and skin disorder (rash/itchy/dermatitis)/ muscle ,back and wrist pain/ Neurological sign (dizziness/faint/ headache, etc.)

4.2 Results of phrase 2: Health risk and health effects assessment

The second phrase was retrospective cohort study for health risk and effects evaluation by questionnaire interviews, chemical exposure and pulmonary function among incense making workers and comparative with non- incense workers who lived in near villages.

4.2.1 Questionnaire interview for health assessment

Characteristics of the study population on table 4.5 were 96 incense workers from 21 factories in two villages and 96 non-incense workers from two villages in the same sub-district. The data collected by questionnaire interviewed for general characteristics, history of work, history of illness and respiratory symptoms etc. as showed in table 4.5-4.7

Table 4.5 showed that the majority of incense workers and non- incense workers were males 88.8% and 86.5% while females consisted only 11.2% and 13.5 % respectively. The averages age in incense workers were 43.2 (43.2±11.3) and non-incense workers 49.2 (49.2±11.1) years old. The majority of incense workers and non- incense workers were in the age group of 35-54 years (62.5 and 58.8 %, respectively). The distribution of person characteristic among these two groups did not differ statistically (*p-0.005*)

The duration of work among incense workers were >10 years (71.9%) while duration of work less than 10 years were 28.1%. The average duration of work was 18.5 years (18.5±11.1). About smoking behaviors, 38.8% of incense workers were smoking and 34.4 % in non-incense workers.

Table 4.5: General characteristics among incense workers (exposure group) and Non - incense workers (non-exposure group)

Characteristics	Incense workers (n=96)		Non-incense workers (n=96)	
	no of cases	(%)	no of cases	(%)
Sex				
male	85	88.8	83	86.5
female	11	11.2	13	13.5
Age (yrs)[a]	43.2±11.3*		49.2±11.1	
Age range	18 - 71		24-71	
15-34 yrs	21	21.9	18	18.6
35-54 yrs	60	62.5	57	58.8
55 yrs and above	15	15.6	21	21.6
Height (CM)[a]	162.8±6.89		163.5±7.82	
Weight (Kg)[a]	59.5±9.51*		57.4±6.54	
BMI[a]	22.4±3.08		21.8±2.81	
Duration of working (year)				
< 10 years	27	28.1	NA	
>10 years	69	71.9		
Duration of working [a]	18.5±11.1		NA	
Duration of working Range (yrs)	2- 45		NA	
Marital status				
Married	82	83.7	88	91.7
single	12	14.3	1	1.00
Widow and separated	2	2.0	7	6.3

Education				
Illiteracy	2	2.0	0	0
Elementary	73	74.5	78	81.3
Junior and senior high school	17	19.4	18	18.7
Bachelor’s degree and above	4	4.1	0	0
Smoking				
Smokers	36	38.8	33	34.4
Non smoker	60	61.2	63	65.6
Alcohol drinking				
Drinking	52	55.1	46	47.9
Non drinking	44	44.9	50	52.1

[a] mean *$p < 0.005$

The General characteristics about acute respiratory symptoms in once week among the incense workers and non- incense workers can be concluded as the following table 4.6. The interviewed for acute respiratory symptoms in once week in 96 incense workers found that the workers who were usually cough in the morning were found 22 workers (22.9%) while had sputum in the morning were found 15 (15.3%). The incense workers who had symptoms about dyspnea, breathlessness, wheezing were found 7 (7.29%), 6 (6.3%), 3 (3.1%) workers, respectively. And acute symptoms about eye, nose, skin irritation were found 19 (19.8 %), 14 (14.6 %) and 12 (12.5%) workers, respectively.

While we found the 96 non incense workers had cough and cough with sputum in the morning were 15 (15.6%) and 12 (12.5 %). While the acute symptoms about eye, nose, skin irritation were found 9 (9.4%), 9 (9.4%), and 8 (8.3%) respectively.

The results showed the comparative the prevalence of acute respiratory symptoms and sign in once week among the incense workers and non- incense workers that the prevalence of irritant nose, block nose and irritant eye was significantly higher in the incense workers than non-incense workers (*$p>0.05$*). Although the difference was not statistically significant, the prevalence of cough and cough with sputum and skin irritant and skin itchy in incense workers group was slightly higher than in non- exposure group.

Table 4.6: Acute respiratory symptoms and sign among the incense workers and non-Incense workers in once week.

Sign and symptoms	Incense workers n (%)	Non-incense workers n (%)	*P-value*
Cough	22 (22.9)	15 (15.6)	0.200
Cough and sputum	15 (15.3)	12 (12.5)	0.399
Dyspnea	7 (7.29)	6 (6.3)	0.774
Breathlessness	6 (6.3)	5 (5.2)	0.756
Wheezing	3 (3.1)	1 (1.0)	0.561
Irritant nose	14 (14.6)	2 (2.1)	0.001*
Block nose	10 (10.4)	3 (3.1)	0.040*
Irritant eyes	19 (19.8)	4 (4.2)	0.001*
Malaise	9 (9.3)	17 (17.7)	0.092
Headache	15 (15.6)	9 (9.4)	0.191
Irritant skin	12 (12.5)	9 (9.4)	0.480
Skin itchy	13 (13.1)	8 (8.3)	0.240

NS: Not significant, *p>0.05*

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Table 4.7 showed the prevalence of various past respiratory symptoms and calculated of OR in both incense workers and non- incense workers. It was seen that the among 96 incense workers examined, 26 (27.1%) workers complained of frequent cough in the morning or on getting up, 16 (16.7%) and 13 (13.6%) workers were reported having phlegm, sputum and mucous and breathlessness and shortness of breath and 26 (27.1%) workers suffers from irritant respiratory tract. The symptoms of skin dermatitis, skin itchy or irritation on face, hand and arm was reported 34 (35.4%) in incense workers.

In case of non-incense workers, the occurrence past respiratory symptoms was much lower than incense workers group, as 17 (17.7%) complained of frequent cough in the morning, 9(9.4%) had breathlessness and shortness of breath and 14 (14.6%) had block nose, nasal stuffiness and nose irritation. The OR value for frequent cough, sputum and mucous, breathlessness, wheezing or whistling, respiratory irritation, skin dermatitis was comparison analyzed in both groups. The unadjusted OR for block nose, nasal stuffiness and nose irritation (2.18), irritation eyes, sore eyes (2.33) and skin dermatitis, skin itchy or irritation on face, hand and arm (2.22) showed that significant excess risk of respiratory illness in incense workers than non-incense workers.

Table 4.7 Comparison of risk of past respiratory symptoms among incense workers (n=96) and Non - incense workers (n=96)

Symptoms	Group study	Presence of Symptoms		Odd ratio
		Yes	No	
Frequent cough in the morning or on getting up	incense workers	26	75	1.73
	non- incense workers	17	79	
phlegm, sputum and mucous	incense workers	16	80	1.17
	non- incense workers	14	82	
breathlessness and shortness of breath	incense workers	13	83	1.51
	non- incense workers	9	87	
chest ever sound wheezing or whistling	incense workers	5	91	2.58
	non- incense workers	2	94	
block nose, nasal stuffiness and nose irritation	incense workers	26	70	2.18*
	non- incense workers	14	82	
irritation eyes, sore eyes	incense workers	24	72	2.33*
	non- incense workers	12	84	
skin dermatitis, skin itchy or irritation on face, hand and arm	incense workers	34	62	2.22*
	non- incense workers	19	77	

*statistically significant

4.2.2 Chemical exposure evaluation

The blood lead level was collected and analyzed for chemical exposure assessment among incense workers and non-Incense workers. The blood lead levels testing were conducted among 25 incense workers and 25 non incense workers are summarized in Table 4.8. The results found that the blood lead levels of incense workers range from 1.6 μg/dL. to as high as 8.2 μg/dL and the average mean in case of non - incense workers range from 1.4 - 6.3 μg/dL.

The average mean of blood lead level among incense workers was 4.76±1.70 μg/dL and non- incense workers was 3.54±1.05 μg/dL. These values showed that the difference in blood lead concentrations was significantly higher in the incense workers than non- incense workers (*p>0.05)*.

Table 4.8: Comparative blood lead level among incense workers and non- incense workers, Roi-et ,Thailand

Groups	n	Min – Max (μg/dL)	Mean (μg/dL)	sd	t-test	df	*p-value*
Incense workers	25	1.6-8.2	4.76	1.70	-2.65	43	0.005*
Non-Incense workers	25	1.4-6.3	3.54	1.05			

*statistics significant

Table 4.9 showed that the odds ratio (OR) values of blood lead level between incense workers and non- incense workers was a significant excess risk of lead exposure among incense workers than non – incense workers (OR=4.50, 95% CI 1.08, 18.77).

When we compared the relative risk (OR) values between duration of incense making (< 5 years , 5-10 years, >10 years) and blood lead level (>5 μg/dL, <5 μg/dL) among incense workers found that the OR were increased for duration of work, the risk of lead exposure was higher and significant OR for workers who have worked duration 5-10 years and more than 10 years (OR = 5.60; 95%Cl 1.30, 25.00 and OR = 4.68; 95%Cl 1.94, 23.27, respectively). Since a majority of incense workers were in making incense stick >10 years, thus a long time exposure to various chemicals such as lead and others heavy metal may be effected and higher health risk in incense workers.

Table 4.9: Comparison of risk of blood lead level among incense workers and non-incense workers and year of duration working in incense workers

Groups exposure	No of cases	Blood lead level		OR	95%Cl
		>5 µg/dl	<5 µg/dl		
		n (%)	n (%)		
non incense workers	25	2 (8.0)	23 (92.0)	1.00	
incense workers	25	9 (36.0)	16 (64.0)	4.50	1.08, 18.77
Duration of incense making (year)	25				
non incense making	25	2 (8.0)	23 (92.0)	1.00	
< 5 years	6	1 (16.7)	5 (83.3)	2.08	0.22, 19.35
5-10 years	11	5 (45.5)	6 (54.5)	5.60	1.30, 25.00
>10 years	8	3 (37.5)	5 (62.5)	4.68	1.94, 23.27

4.2.3 Pulmonary function testing for health effects assessment

Pulmonary function tests were performed at the worksite using Pony graphic spirometer (COSMED, Sri - Italy). The 96 incense workers and 96 non- incense workers were subjected to test at least three times and with a different mouthpiece for each subject. Before the test, age in full years, height and weight of the subjects were entered in the spirometer as showed in Table 4.5. All the subjects were advised to leave smoking one hour before the test and not eat a big meal two hours before doing the test. The spirometer was used to determine the value of Forced Vital Capacity (FVC), Forced Expiratory Volume in 1 second (FEV1), the ratio of FVC to FEV1 (TIFF), FEF25-75 and comparative in both groups. The values were measured three times and the best result of the three measurements was recorded.

The results of pulmonary function tests among incense workers and non- incense workers showed in Table 4.10. The values of FVC in incense workers were lesser (3.2 ± 0.6 L) as compared in non- incense workers (3.4 ± 0.5 L). FEV_1 was also lower (2.8 ± 0.6 L/sc) than controls (3.1 ± 0.4 L/sc). FEV_1/ FVC (%) among incense workers and non- incense workers were 86.6% and

88.6% and FEF_{25-75} in both groups was not difference value. Although the pulmonary function test between groups were not statistically significant difference. All parameter of pulmonary function test were lower in incense workers than controls.

Table 4.10: Comparative of pulmonary function among incense workers and non - incense workers

Pulmonary function	incense workers (n=96)	non-incense workers (n=96)	*P-value*
FVC (L)	3.2 ± 0.6	3.4 ± 0.5	0.372
FEV_1 (L/sc)	2.8 ± 0.6	3.1 ± 0.4	0.419
FEV_1 / FVC (%)	86.6 ± 5.6	88.6 ± 5.8	0.306
FEF_{25-75} (L/sc)	3.5 ± 1.0	3.5± 0.6	0.721

One-way ANOWA applied for comparison in these groups

The mean value of pulmonary function test among incense workers according to during of work (< 10 years and > 10 years) in Table 4.11 as shows a decline in the pulmonary function parameter , FVC, FEV_1/ FVC, FEF_{25-75} in incense workers as duration of work >10 years, 3.2 L, 85.6%, 3.5L when compared with those with < 10 years of exposure were 3.3L, 88.6%, 3.8 L/*sc*, respectively.

Table 4.11 Pulmonary function among incense workers according to during of working.

Pulmonary function	Duration of work		*p*-value
	< 10 years (n=27)	> 10 years (n=69)	
FVC (L)	3.3 ± 0.6	3.2 ± 0.6	0.711
FEV_1 (L/sc)	2.8 ± 0.6	2.8 ± 0.6	0.897
FEV_1 / FVC (%)	88.6 ± 5.6	85.6 ± 5.4	0.038*
FEF_{25-75} (L/sc)	3.8 ± 1.1	3.5 ± 0.9	0.069

*Statistically significant

The table 4.12 showed the comparative mean values of pulmonary function parameter between incense workers and control groups with stratify by smokers and non- smokers. FVC values in incense makers were 3.31 L in smokers and 3.24 L in non- smokers. The observed FVC value both smokers and non- smokers were less than the mean predicted value (3.62L). FEV1 /FVC and FEF_{25-75} value for incense makers were not significantly lower than non- incense workers groups and in either the smokers and non- smokers groups.

While the mean value of all Spiro metrics parameter; FVC, FEV_1, FEV_1/ FVC and FEF_{25-75} in controls group were not significant difference in both smokers and non - smokers. The pulmonary function in smoker workers was better than in non- smoker workers in both incense workers and non- incense workers.

Table 4.12 Pulmonary function among incense workers and non- incense workers, stratified by smoking behaviors

Pulmonary function		Incense workers (n =96)	*p*-value	non-incense workers (n=96)	*p*-value
FVC (L)	non smokers smokers	3.31 ± 0.63 3.24 ± 0.60	0.884	3.50 ± 0.53 3.42 ± 0.60	0.456
FEV_1 (L/sc)	non smokers smokers	2.92 ± 0.54 2.84 ± 0.63	0.414	3.11 ± 0.40 3.03 ± 0.44	0.367
FEV_1 / FVC (%)	non smokers smokers	88.54 ± 5.58 85.51 ± 5.50	0.009*	88.90 ± 6.52 88.44 ± 5.84	0.720
FEF_{25-75} (L/sc)	non smokers smokers	3.81 ± 0.88 3.46 ± 1.05	0.032*	3.58 ± 0.68 3.48 ± 0.65	0.465

*statistically significant

Overall difference is based on one- way ANOVA, P<0.05

4.3 The risk management for health hazards reduction

The results of the environmental workplace assessment and health risk evaluation shown that dust and chemicals were majority hazards and has affected to incense workers who made incense stick in household factory. The necessary planned were implemented for handled to mitigate problem and reduce the as following:

1. The occupational nurse and staff of health promotion hospital should be keeping knowledge and health education for incense and joss stick workers who have been working in household factory , the contents of knowledge include the risk and health effects relate to dust and chemical exposure and personal protection equipment (PPE) using such as mask, gloves and wearing completed clothing during working are necessary.

2. The study found that the incense workers had used personal protection equipment (PPE) only 3.9% and most of all had eaten during working in the workplace. So the local health officers should encourage them to use personal protection equipment (PPE) such as mash, gloves, shoes and wearing protective clothing including bathing and washing hand before eating.

3. The smoking among the incense workers could be enhancing to higher health risk and effects to the respiratory system when comparative with non-incense workers. Therefore, the staff of local health provincial should be recommended the incense workers abstain from smoking.

4. The evaluation of environmental exposure in the household factory found that the hazards such as dust, chemical and residue waste were discarded around the village and may expose and effect to children and others. The workplace management and properly eliminate residue waste from incense making process are important and necessary to continuously implement. The local authority and health volunteer in the villages should develop program for "Safety and healthy workplace " in the small household factory.

5. The incense workers were exposed to dust and residue risk of exposure during working *and* the health surveillance and health service is required to development. The health provincial and health promotion hospital officers should be setting health surveillance system for incense workers and their family. The annual health examination and investigation among workers should be done for monitor their health.

CHAPTER V
DISCUSSION, CONCLUSION

5.1 Discussion

Government policy has supported funds for development to the small and medium scale enterprises (SMEs) in 1997, the funds for resolving effects of the economic crisis. And it was result to SMEs has rapidly expanded to community. The total number of Thai SMEs in 2006 was 2,274,525 and, employment in SMEs was 8,863,334, their employment classified by sector concentrated most in the production sector for 45.3%, followed by 30.0% in service sector, and 24.7% in trade sector. Bangkok and vicinity had the highest employment followed by the northeastern region, the northern region, the eastern region, and the southern, central and western regions respectively. (The2nd SMEs Promotion Action Plan, 2007-2011, OSMEP). The small and medium factories were widely distributed according to communities and villages after the policy development. Many products were produced from community and household for example; dry fruits, silk dying, sewing garment, electronic components, packaging, textiles, shoe-making, furniture, and incense and joss stick etc. However, the distribution of small factories into communities may contribute to occupational and environmental health problems in the future. So it should be awareness and critical to this problem.

The incenses and joss stick is one of product produced from household in community as increasing an extra family income. Since incense and joss sticks products are widely used a round the world. The Egyptian and Babylonian started using the incense for praying and a religious ceremony before 538-586B.C. Both the ancient Greeks and Romans used incense to drive away demons and to gravity the gods. Then, Chinese and Japanese used incense sticks by different type and different occasions. (Incense history, 2000) Nowadays, incense has extensively products developed such as incense making with artificial perfumes for room deodorizers and mixed chemical for repel insects etc. Most of the incense products come from many countries, for example, China, Vietnam, India, Cambodia, Bangladesh, and Thailand etc. The northern and northeast of Thailand is the largest areas for making incense and joss stick.

Generally, the incense stick making normally has made in small household factories because of the process or procedure is not complicated and not use advanced technology. A widely rural location is suitable for incense making especially for incense drying. (Knight L. et al., 2001). Most of the past studies had identified to health effects related to incense smoke. Incense smoke inhalation is associated with lung cancer, asthma (Koo, Ho et al. 1995). An increased risk of leukemia was found for children whose parents burned incense in the home before pregnancy or during nursing period as studied by Lowengart RA.et al.(1987) (Lowengart, Peters et al. 1987). While the studies which focus to occupational health hazards related to incense and joss stick making are few as following by Rathnakara UP et al. (1992). When the risk of health effects among incense workers may be higher risk to expose dust and chemicals during work or incense making. As Liou SH. et al. (1996) indicated that work areas where incense sticks making are greater dust concentrations. The wood dust may affect to the health workers and members in family both elderly and young children in the house. Moreover, Douwes J et al.(2001) and Perez-Rios M et al (2010) studies identified that chronic exposure to wood dust has affected to the respiratory system such as asthma and skin and eye irritation (Douwes, McLean et al. 2001, Pérez-Ríos, Ruano-Ravina et al. 2010).

The largest areas for incense and joss sticks production is *Dong Deang* sub-district in Roi-et province was selected to study for evaluation of environmental exposure and identification hazard and Health risk assessment among incense workers.

The results of this study were discussed into 2 parts; (1) Environmental workplace exposure assessment and hazard identification (2) Occupational Health risk and health effects assessment.

5.1.1 Environmental workplace exposure assessment and hazard identification

Occupational exposure to hazard during working is important factor to cause of illness among workers who working in factory. Therefore, environmental assessment at workplace for hazards identification is important to do for knowing its causes of health effects. Identification hazards and health effects evaluation will be useful to develop measurement for environmental workplace management. This study had evaluated environmental workplace and hazards in small incense and joss stick household factory in Roi et province. *Dong Deang village*, there is the largest areas to incense making and full of small incense stick factories in the village. The results of workplace assessment in nine factories shown that the majority of raw material was dust and chemical used in the process of mixing, rolling and shaking powders. The results of the real time exposure monitoring measured dust and small particle concentrations in workplace in production process found that the dust (PM_{10}) concentrations were high in all the production process especially in stage of rolling and shaking wood powders onto the sticks and packing and wrapping were 0.538 ± 27 and 0.475±.16 mg/m^3. As consist with the previous study in Taiwan which personal air sampling were collected in joss stick manufacturing plant shown that the concentration of total dust in a large incense stick factory was very high in the stage of mixing and rolling sticks with incense powders, between 9.9- 42.7 mg/m3. The same as total dust concentration for mixing workers in Japanese incense and coil incense factory were 9.9-31.1 mg/m^3. (Rathnakara UP et al.,1992). According to study by Liou SH et al.(1996) as found that the total and respirable dust concentration were collected in joss stick makers and two packing workers were 11,1, 21.6, 22.6, and 42.7 mg/m^3 and 1.8, 3.1 mg/m^3, respectively. Therefore, the incense workers who made in the process of mixing, rolling and packing will be the high risk group to expose the dust and aromatic substance. In addition, the concentration of dust (PM_{10}) in the incense factory in this study were higher than an average of dust concentration which was real time detected in a tobacco factory, Bangkok, was 0.374 mg/m^3.(Anuttara P et al.,2009). Health hazards associated with wood dust exposure have been identified in many previous studies. The previous studies to Occupational exposure to wood dust have been well developed to respiratory diseases, asthma, nasal cancer and skin irritation. (Algranti, 2005; Eire, 2006; Douwes et.al**.,** 2001 and Fernandez-Rivas, 1997). Moreover, that amount average mean of small aerosol particles was the highest in the process of aromatics spraying and packing were 9,018.0 PT/ and 8,602.5 PT/cc. and higher than the house without factories.

Heavy metals which were detected in incense products and dyeing dissolved such as Barium) Ba) Cadmium) Cd), Chromium) Cr), Manganese) Mn), Nickel) Ni), and Lead)Pb) were 0.17 ± 0.10, 1.60±0.15, 1.34 ± 0.13, 1.12±0.01, 0.90±0.05, 1.34 ± 0.13 (mg/L±SD), respectively. The incense workers may expose by inhalation, dermal contact and ingestion by eating during work and not suitable hand washing. Although the previous study by Pornrat Kaewrueng et al. (2014) identifies that incense workers may not be getting risk from dermal exposure in their occupational. However, heavy metal especially lead may effect to health in a long-term exposure and effects to a child's development and behavior. (CDC, 2005 and ATSDR, 2007).

In addition, many perfumes used in incense production is a mixture of fragrances such as essential oils and aromatics compounds substances are very important ingredients for a pleasant smell. So we found that amount average mean of small aerosol particles was the highest in the process of aromatics spraying and packing were 9,018.0 PT/ and 8,602.5 PT/cc. Moreover, some studies Hagstrom *et al.* (2008). found that wood often contains exogenous chemicals applied in the course of its processing. These include adhesive, solvents, resin, binders, insecticides and fungicides, waterproofing compounds, paints and pigments, lacquers and vanishes. Many of these are volatile and may be emitted when the wood is treated, heats or incinerated. (EPA., 1995.) And if the raw material of incense making such as sawdust was made from the wood as contained with exogenous chemical and may be exposed to incense makers. Evidence in the previous study shown that some fragrances can cause asthmatic reactions in some individuals, especially those with severe or atopic asthma and can cause headache, dizziness, and nausea etc. (Kumar, Caradonna-Graham et al. 1995, Schmeiser, Gminski et al. 2001). (Frosch PJ et al., 2005)

Mostly incense makers were directly exposed to wood dust and chemicals throughout the day. While the walkthrough found that only 3.9 percent of incense female workers used PPE such as mask and glove during working and had taken a bath or clothes changing before lunch or dinner were 39.2 %. Pornrat et al. (2014) suggest that the incense workers should be used PPE such as gloves and washing their hand after work time can reduce heavy metal residues approximately 97.1-99.8 % and 88.0-97.2% respectively.

Dust and particle measurement, heavy metal testing could identify the hazards in all process of incense making that wood dust and chemical substances can identify to the major hazard and health risk as Table 4.4 Heavy metal included lead in low quality dyeing color and aromatics substances for incense spraying may be effected to respiratory tract and neurological sign and also skin disorder. Moreover, impropriety working behavior and working posture are additional factors and cause of musculoskeletal among incense makers.

5.1.2 Health risk and health effects assessment

According to the second objective to evaluate health risk and health effects related to incense making. The results of this phrase study presented the health assessment by questionnaire interview, Chemical exposure evaluation by blood lead testing and pulmonary function testing. Characteristics of the study population on table 4.5 were 96 incense workers from 21 factories in two villages and 96 non-incense workers. These two groups were not difference general characteristics in age, sex, height and weight.

The interviewed on Table 4.6 showed the comparative the prevalence of acute respiratory symptoms and sign in once week among the incense workers and non- incense workers was not statistically significant, this consistent of study by Liou SH et al.(1996) to presented that although the wood dust exposure levels in joss stick factories was higher than other plants ,the prevalence of respiratory symptoms in joss stick workers were not found to be significantly higher than control groups. Many previous studies have reported increased prevalence of respiratory among workers in others industries such as the furniture factories, sawmill, small handicraft, etc. (Douwes, McLean et al. 2001,Knight, Levin et al. 2001, Osman, Douglas et al. 2007). While the prevalence of irritant nose, block nose and irritant eye was significantly higher in the incense workers than non- incense workers (*$p>0.05$*). Although the difference was not statistically significant, the prevalence of cough and cough with sputum and skin irritant and skin itchy in incense workers group was slightly higher than in non-exposure group. The current study showed a significantly higher prevalence of the past respiratory symptoms as block nose, nasal stuffiness and nose irritation, irritation eyes, sore eyes, skin dermatitis, skin itchy or irritation on face, hand and arm in incense workers comparison with non-incense workers with OR value 2.58, 2.18, 2.33, respectively and contrast of the Liou SH study. However, the prevalence respiratory symptoms among incense workers did not have unlike significantly higher than control groups. Difference may be due to various factors, i.e., duration of work or exposure, health behaviors, type and size of wood and ventilation as according to Mikkelsem et al., (2002) studied found that the wood dust exposure level were influenced by airflow field in the working areas, the workers inhalation rate and the ventilation system, while the level of its toxicity varies with the characteristics of wood dust.

The value of pulmonary function tests showed a reduction of incense workers was not significantly difference from non-incense workers. However, the values of FVC, FEV_1 and FEV_1/ FVC (%) in incense workers were lesser than non-incense workers exception of FEF_{25-75} in both groups was not significantly difference value. While the mean value of all spirometrics parameter; FVC, FEV_1, FEV_1/ FVC and FEF_{25-75} in controls group were not significant difference in both smokers and non - smokers. The pulmonary function in smoking workers was better than in non-smoking workers in both incense workers and non- incense workers as consist of Liou SH et al.(1996) study that presented the value of FVC, FEV_1/ FVC for joss stick workers were not significantly lower than control group, in either the smokers and non-smokers. However, duration of work and the time of exposure may have related to pulmonary function value. As Larama MB Rongo et al.,(2005) found the mean FVC for high- and low-exposure workers in small scale wood industries in Tanzania were 3.7 L and 3.9 L. The results on Table 4.11 showed the mean value of pulmonary function test among incense workers according to during of work (< 10 years and > 10 years), a decline in the pulmonary function parameter , FVC, FEV_1/ FVC, FEF_{25-75} as duration of work >10 years were 3.2 L, 85.6%, 3.5L when compared with those with < 10 years of exposure were 3.3L, 88.6%, 3.8 L/*sc*, respectively. This contrast with Larama MB Rongo study in 2001 was found that did not significant differences in mean FEV1 in high-exposure workers compared with low-exposure workers (2.9 L/s and 3.2 L/s), The finding of a weak and statistically significant mean of pulmonary function value not clearly associated with among incense and non - incense workers.

As according to the environmental workplace assessment, we found that heavy metal contaminated into incense products and dissolved dyeing, therefore the blood lead level was carried out for evaluation of health risk among 25 workers and 25 non-workers and summarized in Table 4.8. The results found that the average mean of blood lead level among incense workers was 4.76±1.70 μg/dL and non- incense workers was 3.54±1.05 μg/dl

There were differ significant between incense workers and non- incense workers ($p>0.05$). The relative risk (OR) values between duration of incense making (< 5 years, 5-10 years, >10 years) and blood lead level (>5 μg/dl, <5 μg/dl) among incense workers found that the OR were increased for duration of work to 5-10 years, >10 years, (OR = 5.60; 95%Cl 1.30, 25.00 and OR = 4.68; 95%Cl 1.94, 23.27, respectively). Since a majority of incense workers were in making incense stick >10 years, thus a long time exposure to various chemicals such as lead and others heavy metal may be effected and higher health risk in incense workers. The evaluated lead level among incense and joss stick workers have never analyzed in the previous study. Many the past study presented to blood lead level among workers such as battery workers, recycle factory ,etc.(D'Souza Sunil Heman et al.,2007; **Menezes G** et al.,2003)

5.2 Limitation of this study

There are limitation in this research should be noted as following:

1. Selection bias: This study were conducted in household factory in the village. The exposure groups were selected by random sampling from 10 villages where have been incense making and non- exposure groups were selected from two village have not made incense and joss sticks. The selected bias in non- exposure groups found that they have ever made incense stick before so they were excluded from the groups.

2. Pulmonary function detected bias: The subjects were not advised and act up to criteria for testing such as leave smoking one hour before the test and not eat a big meal two hours before doing the test, etc.. And some subjects may be bias by technic and method for detecting.

3. The areas study: This study was conducted only one areas in Roi et province where is the largest for incense stick making and many areas in Thailand have made incense products but they were not selected for studying.

5.3 Conclusion

The finding of this study show that the incense workers are the high risk group of occupational health effects have results from exposed to dust and chemical during working in incense small household factory owing to improperly control and manage the hazardous waste such as dust, dissolved dyeing and waste residue water. Moreover almost workers did not aware to chemicals using during working, we could see that they did not use PPE, cleaned body before eating. Although the health effects assessment may not be clearly associated with pulmonary function testing and respiratory symptoms between incense workers and non- incense workers. The irritation the respiratory tract was identified in some workers who had worked more than 10 years and smoking. Children and the others in village may be exposed to dust and residue dyeing which spread around the village especially the finding of lead exposure in blood's workers and contaminated in dyeing dissolved. Children will get lead in their bodies by tent to put their hands into their mouths; the high dose of lead has effects to the brain developing in children. This study will lead to strongly vouch for setting health surveillance in community. Knowledge for reducing the health risk, Personal Protection Equipment (PPE) using should be developed for reducing the hazards in small household factory.

5.4 Future research

The further study should be focus to;

1. Development program for reducing waste and environmental workplace management..
2. Study to lead exposure assessment in children in household factory and the villages.
3. Setting the health surveillance and service system for incense workers and family

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APPENDIX A

ID ....

Appendix A (English version)

QUESTIONNAIRE INTERVIEW

Health risk assessment associate with wood dust exposure

and risk management among incense and joss stick workers Roi-et province, Thailand

Can you read and fill in the blanks , Choose the answer that appears most appropriate:

Part I : General Information

1. Name.. ID Card ....
2. Gender ( ) Male ( ) Female Age ....years
3. Married Status ( ) single ( ) married ( ) widow -widower
   ( ) divorce/separate
4. Education Background
   ( ) Illiteracy ( ) Elementary school ( ) Junior high school
   ( ) Senior high school and Technical school ( ) Diploma
   ( ) Bachelor's degree and above
5. What is your occupational ?
   ( ) Agriculture /farmers ( ) Industry worker (specify)................................
   ( ) General and Services worker ( ) Merchant
   ( ) Government ( ) Others ....
6.. How long have you been here ? ....years
7. How many members in your family? ....persons
   ( ) 0 – 14 years (.............persons) ( ) 15-59 years (........persons)
   ( ) more than 60 years (...........persons)
8. Do you make incense and joss stick for your occupation
   ( ) no (skip to question no.10)
   ( ) yes (. if you say " yes "go to question no. 9)

Part II : Occupation history

9. Follow question no.8 if you say "yes"
   9.1 When do you begin to make incenses and joss stick ? Year ....
   9.2 How long have you made the incenses and joss stick product ? ....years
   9.3 How many people in your family make incense and joss stick ? ....persons
   ( ) 0 – 14 years (.............persons) ( ) 15-59 years (...............persons)
   ( ) more than 60 years (...........persons) ( ) None

9.4 What do you do in the incense making process? (choose more than one chioce)

( ) Preparation of bamboo ( ) Mixing diferent incense powders

( ) Immerse a bundle of bamboo stick in water ,rolling and shaking wood powder onto the stick.

( ) Dipping into colored and dying incense

( ) Spraying aromatic perfume and packing

( ) Packing ( ) Others ……………………………………

9.5 Working duration ………………………………hour …………. hour /day. ……day/week

10. Have you ever worked : (fill in the blank which the subject has worked)

NO	Work history	place /factory	Year/Duration
1.	……………………………………	…………………………………	……………..
2	……………………………………	…………………………………	……………..
3.	……………………………………	…………………………………	……………..
4.	……………………………………	…………………………………	……………..
5	……………………………………	…………………………………	…………………..

11. Have you ever worked in other? Record on lines the number of years in which the subject

Has worked in any of the below listed industries.

11.1 In a mine ( ) Yes ( ) No years …………….

11.2 In a quarry ( ) Yes ( ) No years …………….

11.3 In a foundry ( ) Yes ( ) No years …………….

11.4 In a pottery ( ) Yes ( ) No years …………….

11.5 In a cotton, flax, or hemp mill ( ) Yes ( ) No years …………….

11.6 With asbestos ( ) Yes ( ) No years …………….

11.7 In any other dusty jobs ( ) Yes ( ) No years …………….

Specify ……………………………………………………….

12. Do you now smoke? ( ) Yes go to question 14 -16 ( ) No(skip to question 18)

13. Have you ever smoked? ( ) Yes go to question 14-17 ( ) No(skip to question 18)

14. Duration of smoking …………………..years

15. You smoke about …………………….unit /day

16. How old were you when you started smoking? ………………. (age-yrs.)

17. When you last gave up smoking? ……………(age-yrs.)

18. Have your members in family has smoking?

( ) Yes (number ……………persons) ( ) No

19. Have you ever used personal protection equipment and good hygiene in working

time

19.1 clothing ( ) No wear ( ) wear sometimes ( ) wear every time

19.2 shoes wearing ( ) No wear ( ) wear sometimes ( ) wear every time

19.3 mash protection ( ) No wear ( ) wear sometimes ( ) wear every time

19.4 washing hand after work and before meal

( ) Never ( ) sometimes ( ) every time

Part IV : History of illness

20. Family history , Have you any your parents, brother ,sister ever had :

( ) High blood pressure
( ) Stroke
( ) Diabetes
( ) Asthma
( ) Tuberculosis
( ) Cancer
(specific)..
( ) Heart problem
( ) Mental disorder
( ) Nervous disease
( ) Allergy ....
( ) Rhinitis
( ) Liver and hepatitis
( ) Lung diseases
( ) Other specify...................................

21 Do you currently take medicine for any of the following problems?

( ) High blood pressure ( ) Breathing and lung problem
( ) Stroke ( ) Heart problem
( ) Diabetes ( ) Dermatitis
( ) Tuberculosis ( ) Cancer ....
( ) Asthma ( ) Allergy
( ) Back pain and muscle strain( ) Chronic Bronchitis
( ) Nervous disease (headache, dizzy, nausea and vomiting, change in cognitive status, motor and sensory abnormalities)
( ) Others (specify) ....

22 Have you ever allergy to drugs , food, pollen, substands, others: ( ) Yes ( ) No
.

If "yes" list any allergies ....

23 Have you ever had an injury or operation affecing your chest? ( ) Yes ( ) No
.

24 How many illnesss have you had in the past three years? ....times
.

25 How do you manage for your illness?

( ) given medicine for yourself ( ) private clinic or private hospital

( ) Local health center ( ) District hospital

( ) Province hospital ( ) Other .....

Part V : **Acute and current of respiratory symptoms**

26 Do you usually cough at first time in the morning or on getting up ?

( ) Yes ( ) No

27 Do you usually cough during the day or at night in the winter ?

( ) Yes ( ) No

28 Do you usually bring up phlegm, sputum and mucous from your chest first thing in the morning? (on getting up)

( ) Yes ( ) No

29 Do you have dyspnea or cheat tightness in working time ?

( ) Yes ( ) No

30 Do you have breathlessness and shortness of breath when hurrying on level ground or walking up a slight hill?

( ) Yes ( ) No

31 Do you have to stop for breath when walking at your own place on level ground?

( ) Yes ( ) No

32 Do you have chest ever sound wheezing or whistling?

( ) Yes ( ) No

33 Do you have sneezing, runny nose, block nose, nasal stuffiness and nose irritation ?

( ) Yes ( ) No

34 Do you have irritation eyes, conjunctivitis or sore eyes ?

( ) Yes ( ) No

35 Do you have skin dermatitis, skin itchy or irritation on face, hand and arm ?

( ) Yes ( ) No

Acute symptoms and frequency of work relate symptom in once week

Record in blank of the lists of symptoms in which the subject has ever had in any of the below :

symptoms		yes	no	Frequency of symptoms in once week		
				once a week	> 1 once week	everyday
36.	cough					
37.	cough &sputum					
38.	dyspnea					
39.	breathlessness					
40.	wheezing					
41.	irritant nose					
42.	block nose					
43.	irritant eyes					
44.	malaise					
45.	headache					
46.	irritant skin					
47.	skin itching					

Name's interviewer .... Tel ....

Date of interview ..../........./...........

APPENDIX B

ลำดับที่ ....

Appendix B (THAI version)

แบบสอบถามโครงการวิจัย

การประเมินความเสี่ยงและการจัดการความเสี่ยงสุขภาพจากการสัมผัสฝุ่นไม้ของคนงานทำธูป จังหวัดร้อยเอ็ด ประเทศไทย

คำชี้แจง : จงเติมคำลงในช่องว่าง และทำเครื่องหมาย X ลงในคำตอบที่ถูกต้องและเป็นข้อเท็จจริงมากที่สุด

ข้อคำถามประกอบด้วยข้อมูลที่สำคัญ 5 ส่วน ดังนี้

(1) ข้อมูลทั่วไป ได้แก่ ข้อมูลด้านเพศ อายุ การศึกษา สถานภาพสมรส อาชีพ และที่อยู่อาศัย เป็นต้น

(2) ข้อมูลประวัติการทำงานในอดีต

(3) ข้อมูลด้านพฤติกรรมสุขภาพ ได้แก่ การสูบบุหรี่ การดื่มเครื่องดื่มแอลกอฮอล์ เป็นต้น

(4) ข้อมูลประวัติการเจ็บป่วย

(5) ข้อมูลอาการระบบทางเดินหายใจปัจจุบัน

ผู้วิจัยของรับรองว่าข้อมูลที่ได้จากการสอบถามของท่าน จะใช้ประโยชน์เพื่อการศึกษาวิจัยนี้เท่านั้น และจะเป็นข้อมูลที่เป็นความลับ ไม่เปิดเผยต่อผู้อื่น โดยที่ไม่ได้รับความยินยอมจากท่าน

ส่วนที่ 1 : ข้อมูลทั่วไป

1. เพศ ( ) ชาย ( ) หญิง อายุ ....ปี
2. สถานภาพสมรส ( ) โสด ( ) สมรส ( ) หย่าร้าง แยกกันอยู่ ( ) หม้าย

3. ระดับการศึกษา

   ( ) 1. ไม่ได้เรียน ( ) 2. ระดับประถมศึกษา ( ) 3. ระดับมัธยมศึกษาตอนต้น (ม. 1-3)

   ( ) 4. ระดับมัธยมศึกษาตอนปลาย (ม. 4-6) หรือปวช. ( ) 5. ประกาศนียบัตร หรือ ปวส.

   ( ) 6. ระดับปริญญาตรี ( ) 7. สูงกว่าระดับปริญญาตรี

4. ปัจจุบันท่านประกอบอาชีพอะไร?

   ( ) เกษตรกรรม ( ) รับจ้าง ในโรงงานอุตสาหกรรม (ระบุ)...................................

   ( ) รับจ้างและงานบริการทั่วไป (ระบุ)..

   ( ) ค้าขาย หรือประกอบธุรกิจส่วนตัว (ระบุ)...

   ( ) รับราชการ และรัฐวิสาหกิจ ( ) อื่น ๆ ....

5. ท่านอาศัยอยู่ในชุมชนนี้มานาน ....ปี
6. จำนวนสมาชิกในครอบครัวของท่าน ....คน

   ( ) อายุระหว่าง 0 – 14 ปี จำนวน..........คน

   ( ) อายุระหว่าง 15 - 59 ปี จำนวน........คน

   ( ) อายุมากกว่า 60 ปี จำนวน ....คน)

7. ปัจจุบันท่านและครอบครัวของท่านประกอบอาชีพทำธูปในชุมชนหรือไม่ ?
( ) ไม่ทำ (ข้ามไปข้อคำถามที่ 9)
( ) ทำ (ถ้าตอบว่า " ทำ " เริ่มตอบคำถามตั้งแต่ข้อที่ 8)

ส่วนที่ 2 : ประวัติการประกอบอาชีพ

8. จากคำถามข้อที่ 7 ถ้าตอบว่า " ทำ " จงตอบคำถามข้อต่อไปนี้
8.1 ท่านเริ่มประกอบอาชีพทำธูป ตั้งแต่ ปี พ.ศ. ....
8.2 ท่านประกอบอาชีพทำธูปนานเป็นเวลา...........................ปี
8.3 จำนวนสมาชิกในบ้านที่ประกอบอาชีพทำธูป ....คน จำแนกเป็น
( ) กลุ่มอายุระหว่าง 0 – 14 ปี จำนวน..........คน
( ) อายุระหว่าง 15-59 ปี จำนวน...........คน
( ) อายุมากกว่า 60 ปี จำนวน..........คน
( ) ไม่มี
8.4 ลักษณะงานที่ท่านทำในกระบวนการผลิตธูป ?
(เลือกตอบได้มากกว่า 1 ข้อ)
( ) 1. เตรียมไม้ไผ่ ทำก้านธูป ( ) 2. ผสมวัตถุดิบ(ฝุ่นไม้ ขี้เลื้อย ยางไม้และอื่น ๆ)
( ) 3. การคลุกร่อน และพอกธูป ( ) 4. การผสมสีและชุบสีธูป
( ) 5. การนำธูปไปตาก ( ) 6. การสเปรย์ น้ำหอม ( ) 7. การห่อ บรรจุ
( ) 8. อื่น ๆ ....
8.5 ระยะเวลาในการทำธูป ....ชั่วโมง /วัน ....วัน/สัปดาห์

9. ประวัติการทำงานในอดีต ที่ผ่านมา: (ลงรายละเอียดข้อมูลลงในช่องที่กำหนด)

ลำดับ	ลักษณะงาน	โรงงาน/สถานที่ทำงาน	ปี/ระยะเวลาที่ทำ
1.			
2			
3.			
4.			
5.			

10. ท่านเคยทำงานในอุตสาหกรรมต่อไปนี้หรือไม่ ? โปรดระบุ ระยะเวลาที่ท่านเคยทำ

10.1 การทำเหมืองแร่ต่าง ๆ ( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.2 ทำงานในโรงโม่หิน ( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.3 ทำงานในโรงหลอมโลหะ ( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.4 โรงงานเครื่องปั้นดินเผา ทำอิฐ ( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.5 โรงงานทอผ้า ป่าน ปอ ลินิน ( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.6 โรงงานกระเบื้อง หลังคา ผ้าเบรกและอื่น ๆ ที่เกี่ยวข้องกับใยหิน

( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

10.7 โรงงานอื่น ๆ ที่ต้องสัมผัสกับฝุ่น ก๊าซ ไอสารระเหย ระบุ...

( ) ไม่เคยทำ ( ) เคยทำ ระยะเวลา ....ปี

ส่วนที่ 3 : ข้อมูลพฤติกรรมสุขภาพ

11. ปัจจุบันท่านสูบบุหรี่หรือไม่ ?
( ) สูบ (ตอบคำถามข้อที่ 14 – 16 ( ) ไม่สูบ (ข้ามไปตอบคำถามข้อที่ 18)
12. ท่านเคยสูบบุหรี่หรือไม่? ( ) ไม่เคย (ข้ามไปตอบคำถามข้อที่ 17)
( ) เคย (ตอบคำถามข้อที่ 13-17)
13. ระยะเวลาที่สูบบุหรี่ .... ปี
14. สูบบุหรี่ ประมาณ .... มวน/วัน
15. ท่านเริ่มสูบบุหรี่เมื่ออายุ ....ปี
16. ถ้าเลิกสูบแล้ว ท่านเลิกสูบมาแล้ว ....ปี
17. สมาชิกในบ้านของท่านมีคนสูบบุหรี่หรือไม่?
( ) ไม่มี ( ) มี จำนวน ....คน
18. ปัจจุบันท่านดื่มสุรา หรือเครื่องดื่มแอลกอฮอล์หรือไม่ ?
( ) ดื่ม (ตอบคำถามข้อที่ 19 – 26) ( ) ไม่ดื่ม (ข้ามไปตอบคำถามข้อที่ 27)
19. ท่านดื่มสุรามานาน .... ปี เริ่มดื่มเมื่อ อายุ .... ปี
20. ลักษณะการดื่มสุรา( ) ดื่มทุกวัน วันละ ....แก้ว ( ) ดื่มสัปดาห์ละ 3-4 วัน วันละ ....แก้ว
( ) ดื่มสัปดาห์ละ 1-2 วัน วันละ ....แก้ว ( ) ดื่มนาน ๆ ครั้ง หรือตามเทศกาล...
21. ช่วงเวลาที่ท่านดื่มสุรา ....น. ระยะเวลาที่ใช้ดื่มสุรา ....ชั่วโมง
22. ประเภทสุราที่ท่านดื่ม ระบุ (ชนิด ยี่ห้อ) ....
23. สุราที่ท่านดื่ม ได้มาจาก (ตอบได้มากกว่า 1 ข้อ)
( ) เพื่อนบ้านหามาให้ดื่ม ( ) ซื้อในร้านค้าในหมู่บ้าน ( ) ซื้อจากในเมือง จังหวัดหรือที่อื่น ..
( ) อื่น ๆ ....
24. ลักษณะการดื่มสุรา ( ) ดื่มคนเดียวในบ้าน ( ) ดื่มร่วมกับคนในบ้าน ( ) ดื่มกับเพื่อนนอกบ้าน
( ) อื่น ๆ ....
25 ท่านมีค่าใช้จ่ายในการซื้อสุราดื่มครั้งละ ....บาท เฉลี่ยเดือนละ ....บาท
26. สมาชิกในบ้านของท่านมีคนดื่มสุราหรือไม่ ?
( ) ไม่มี ( ) มี จำนวน..............คน ระบุ ....

27. ระหว่างทำงานท่านปฏิบัติตนอย่างถูกสุขลักษณะและใช้เครื่องป้องกันส่วนบุคคล ดังนี้ หรือไม่ ?
    27.1 สวมเสื้อผ้า มิดชิด ( ) ไม่สวม ( ) สวมบางครั้ง ( ) สวมทุกครั้งที่ทำงาน
    27.2 สวมรองเท้า ( ) ไม่สวม ( ) สวมบางครั้ง ( ) สวมทุกครั้งที่ทำงาน
    27.3 สวมหน้ากาก/ผ้าปิด ( ) ไม่สวม ( ) สวมบางครั้ง ( ) สวมทุกครั้งที่ทำงาน
    27.4 ล้างมือก่อนและหลังรับประทานอาหาร ( ) ไม่ล้าง ( ) ล้างบางครั้ง ( ) ล้างทุกครั้ง
    27.5 ทำความสะอาดร่างกายทันทีหลังเลิกงานหรือก่อนทำกิจกรรมอื่น ๆ
    ( ) ไม่ทันที ( ) เป็นบางครั้ง ( ) ทันทีทุกครั้งทีเลิกงาน

ส่วนที่ 4 : ประวัติการเจ็บป่วย

28. ประวัติการเจ็บป่วยของสมาชิกในครอบครัว (บิดามารดา พี่น้อง ฯ ป่วยหรือเสียชีวิต ด้วยโรคดังต่อไปนี้ หรือไม่

( ) ความดันโลหิตสูง	( ) โรคหัวใจ
( ) โรคหลอดเลือด	( ) โรคทางจิต
( ) โรคเบาหวาน	( ) โรคทางประสาท
( ) หอบหืด	( ) โรคภูมิแพ้ ....
( ) วัณโรค	( ) โรคจมูกอักเสบจากการแพ้
( ) โรคมะเร็ง	( ) โรคตับและตับอักเสบ
ระบุ....................................	( ) โรคปอด ระบุ ....
	( ) อื่น ๆ ....

29. ท่านมีโรคประจำตัวที่ต้องรับยาเป็นประจำขณะนี้หรือไม่
    ( ) ไม่มี ( ) มี ระบุ โรค 1. ....
    2...

30. ท่านมีประวัติป่วยเป็นโรคดังต่อไปนี้

( ) ความดันโลหิตสูง	( ) โรคปอดอักเสบ
( ) โรคหลอดเลือดสมอง	( ) โรคหัวใจ
( ) โรคเบาหวาน	( ) โรคผิวหนัง
( ) วัณโรค	( ) โรคมะเร็ง ระบุ.............................
( ) หอบหืด	( ) โรคภูมิแพ้
( ) โรคกระดูกและกล้ามเนื้อ	( ) โรคหลอดลมอักเสบเรื้อรัง

    ( ) อาการทางระบบประสาท (ปวดศีรษะ, งุนงง, คลื่นไส้ อาเจียน, ระบบความจำเปลี่ยนแปลง,ความผิดปกติของระบบการเคลื่อนที่ ฯลฯ)
    ( ) อื่น ๆ (ระบุ) ....

31. ท่านเคยมีประวัติการแพ้ยา อาหาร ละอองเกสรดอกไม้ สารเคมี และอื่น ๆ หรือไม่?
    ( ) ไม่เคย ( ) เคย
    ถ้า "เคย" โปรดระบุ สิ่งที่แพ้ ....

32. ท่านเคยได้รับการบาดเจ็บ หรือผ่าตัด บริเวณทรวงอกหรือไม่ ? ( ) ไม่เคย ( ) เคย

33. ในรอบ 3 ปี ที่ผ่าน ท่านเคยเจ็บป่วย ....ครั้ง

34. เมื่อมีอาการเจ็บป่วยเกิดขึ้น ท่านรักษาตัวเองอย่างไร ?

( ) ซื้อยากินเอง ( ) ไปรักษาที่คลินิกแพทย์ ( ) รักษาที่โรงพยาบาลเอกชน

( ) รักษาที่สถานีอนามัย/รพ ตำบล ( ) รักษาที่โรงพยาบาลชุมชน

( ) รักษาที่โรงพยาบาลทั่วไป/รพ. ศูนย์ ( ) อื่น ๆ ระบุ ....

35. กรณีที่ท่านเข้ารับการรักษาในสถานพยาบาล อย่างไร?

( ) จ่ายค่าใช้จ่ายเอง ( ) ใช้บัตรสงเคราะห์ ( ) ใช้สิทธิ 30 บาท /บัตรทอง

( ) ใช้บัตรประกันสังคม ( ) เบิกตามสิทธิราชการ ( ) อื่น ๆ ระบุ ....

36. ท่านเคยตรวจสุขภาพประจำปี หรือไม่

( ) ไม่เคย ( ) เคย ถ้า “เคย” ตรวจครั้งสุดท้าย เมื่อ ....

37. กรณีที่ท่านประกอบอาชีพทำธูป ท่านเคยได้รับอุบัติเหตุหรือคิดว่าป่วยจากการทำธูปหรือไม่?

( ) ไม่เคย ( ) เคย ถ้า “เคย” โปรดระบุ ....

ส่วนที่ 5 : อาการปัจจุบันของระบบทางเดินหายใจเฉียบพลัน

38. ท่านมีอาการไอเป็นประจำ ในตอนเช้าหลังตื่นนอน หรือไม่

( ) ไม่มี ( ) มี

39. ท่านมีอาการไอในช่วงกลางวัน หรือ ช่วงกลางคืนในฤดูหนาวหรือไม่

( ) ไม่มี ( ) มี

40 ท่านมีอาการไอ มีเสมหะในลำคอ จากทรวงอกครั้งแรกในตอนเช้าหลังตื่นนอนหรือไม่

( ) ไม่มี ( ) มี

41. ท่านมีอาการแน่นหน้าอก หายใจลำบาก ขณะทำงานหรือไม่?

( ) ไม่มี ( ) มี

42. ท่านมีอาการเหนื่อยหอบระหว่างการเดินเร็ว ๆ บนพื้นราบ เดินขึ้นเนินสูง หรือขณะขึ้นบันได หรือไม่ ?

( ) ไม่มี ( ) มี

43. ท่านต้องหยุดพัก เพื่อการหายใจสะดวกขึ้น ขณะเดินในพื้นราบหรือไม่?

( ) ไม่มี ( ) มี

44. ท่านเคยมีอาการหายใจมีเสียงดัง หรือมีเสียงหวีดเวลาหายใจหรือไม่?

( ) ไม่มี ( ) มี

45. ท่านมีอาการจาม น้ำมูกไหล คัดจมูก ระคายเคืองจมูก หรือไม่ ?

( ) ไม่มี ( ) มี

46. ท่านมีอาการระคายเคืองตา แสบตา หรือเยื่อบุตาอักเสบหรือไม่ ?

( ) ไม่มี ( ) มี

47. ท่านมีอาการโรคผิวหนังอักเสบ ระคายเคือง คันผิวหนังบริเวณหน้า มือ แขน หรือตามส่วนต่าง ๆ ของร่างกายหรือไม่ ?

( ) ไม่มี ( ) มี

อาการแสดงเฉียบพลันที่เกี่ยวข้องกับการทำงานที่เกิดขึ้นใน 1 สัปดาห์

อาการแสดง		ไม่มี	มี	ความถี่ที่เกิดขึ้นในแต่ละสัปดาห์		
				สัปดาห์ละครั้ง	> 1 ครั้ง/สัปดาห์	ทุกวัน
48	ไอ					
49.	ไอและมีเสมหะ					
50.	แน่นหน้าอก					
51.	หายใจลำบาก					
52.	หายใจมีเสียงหวีด					
53.	ระคายจมูก					
54.	คัดจมูก					
55.	ระคายเคืองตา					
56	วิงเวียน					
57.	ปวดศีรษะ					
58.	ระคายเคืองผิวหนัง					
59.	คันผิวหนัง					
60	อื่น ๆ ระบุ					

ชื่อผู้สัมภาษณ์ .... Tel ....

วันที่สัมภาษณ์ ....

VITA

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1978 – 1981 Nursing Bachelors Degree
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Publication and Presentation

1. Oral presentation

The 4th International Conference on public health among greater Mekong Sub-Regional Countries on the 15-16 Sep 2012, Kunming, China "Environmental Workplace Assessment And Hazardous Identification in incense And Joss Stick Making In Small Household Factories, Roi-Et Province, Thailand" (Oral presentation)

2. Oral presentation

The 9th International Conference on Environmental and public Health Management: Toward Better Health and Well Being on 2-4 October 2012 Thailand "Environmental Workplace Assessment And Hazardous Identification In Incense And Joss Stick Making In Small Household Factories, Roi-Et Province, Thailand" (Oral presentation) : The best awards presentation

3. Poster presentation

Environment and health Conference 2013, Basel, Switzerland , 20-23 August : " Hazardous Identification and health risk assessment related to incense and joss The Travel awards