Hearing Loss in Relation to Occupational Noise Levels among Workers in a Polyester Fiber Factory in Thailand

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การเสื่อมสมรรถภาพการได้ยินที่เกี่ยวข้องกับระดับเสียงจากการทำงานของคนงานในโรงงานผลิตเส้นใยโพลีเอสเตอร์ในประเทศไทย

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ยมุนา เจือไธสง : การเสื่อมสมรรถภาพการได้ยินที่เกี่ยวข้องกับระดับเสียงจากการทำงานของคนงานในโรงงานผลิตเส้นใยโพลีเอสเตอร์ในประเทศไทย (Hearing Loss in Relation to Occupational Noise Levels among Workers in a Polyester Fiber Factory in Thailand) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: นพ. โรเบิร์ท เอส. แชบเม็น, 80 หน้า.

ระดับเสียงดังเป็นปัญหาที่พบได้ทุกภูมิภาคทั่วโลกและเกี่ยวข้องกับหลายอาชีพ เช่น การทำงานในโรงงานอุตสาหกรรม ในประเทศไทย อุตสาหกรรมการผลิตเส้นใยสังเคราะห์เป็นอุตสาหกรรมประเภทหนึ่งที่พบระดับเสียงดังจากการทำงาน ดังนั้นการศึกษาครั้งนี้จึงทำการศึกษาในโรงงานอุตสหกรรมผลิตเส้นใยโพลีเอสเตอร์ในจังหวัดปทุมธานี ซึ่งเป็นการศึกษาภาคตัดขวาง ดำเนินการระหว่างเดือนพฤษภาคม-มิถุนายน 2558 วัตถุประสงค์ของการศึกษาครั้งนี้เพื่อทำการศึกษาความชุกของโรคหูเสื่อมจากการทำงาน และปัจจัยเสี่ยงที่เกี่ยวข้องกับโรคหูเสื่อมจากการทำงานของคนงานผลิตเส้นใยโพลีเอสเตอร์ ทั้งหมด 119 คน การศึกษาครั้งนี้ดำเนินการในพื้นที่กระบวนการผลิต Cutting, Spinning, Drawing ซึ่งเป็นพื้นที่ที่ระดับเสียงเฉลี่ยตลอดระยะเวลา 8 ชั่วโมงการทำงานมากกว่า 85 เดซิเบล(เอ) จากการศึกษาพบว่าความชุกของโรคหูเสื่อมจากการประกอบอาชีพเท่ากับ 7.6%

เมื่อทำการวิเคราะห์หาความสัมพันธ์ระหว่างปัจจัยเสี่ยงที่ทำให้เกิดโรคและโรคหูเสื่อมจากการประกอบอาชีพ โดยใช้สถิติการวิเคราะห์สองตัวแปร (bivariate analysis) และการวิเคราะห์การถดถอยโลจิสติก (multiple logistic regression) พบว่า 1. ระดับเสียงในพื้นที่ทำงานไม่มีความสัมพันธ์กับโรคหูเสื่อมจากการทำงานอย่างมีนัยสำคัญทางสถิติ ($p>0.05$) 2. พนักงานผู้ที่สวมใส่ปลั๊กอุดหูบางครั้งขณะทำงานมีความเสี่ยงต่อกับเป็นโรคหูเสื่อมจากการทำงานมากกว่าพนักงานผู้ที่สวมใส่ปลั๊กอุดหูตลอดเวลาขณะทำงานอย่างมีนัยสำคัญทางสถิติ 3. ปัจจัยเสี่ยงต่อการทำให้เกิดโรคหูเสื่อมจากการทำงานมีความสัมพันธ์กับการเสื่อมการได้ยินของหูข้างขวา มากกว่าการเสื่อมการได้ยินของหูข้างซ้ายหรือหูข้างใดข้างหนึ่ง

แม้ว่าความชุกของโรคหูเสื่อมจากการทำงานในการศึกษาครั้งนี้จะมีค่าน้อย อย่างไรก็ตามเพื่อป้องกันมิให้พนักงานเป็นโรคหูเสื่อมจากการทำงานเพิ่มขึ้นในอนาคต ควรพิจารณาสนับสนุนดำเนินการโครงการอนุรักษ์การได้ยิน รวมทั้งการให้ความรู้ความเข้าใจกับพนักงานที่ทำงานในโรงงานอุตสหกรรม

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต .....

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Excessive occupational noise is a problem in all regions around the world and associated with almost every work activity such as manufacturing. In Thailand, synthetic fiber factory is the one business which has high noise level in the workplace. So this study is cross-sectional study which conducted in a Polyester Fiber factory in Pathumthani province during May-June 2015. The purposes of this study to find the prevalence of hearing loss and risk factors associated with hearing loss of Polyester Fiber workers total 119 persons. The study areas are cutting, spinning, drawing process which average 8 hours of noise level in some areas are more than 85 dB(A). The prevalence of hearing loss is 7.6%.

After analyzed the association between independent variables with dependent variables by bivariate analysis and multiple logistic regression, there were 3 major findings as follows: 1. There was no significantly association of any hearing loss with either of the measured noise levels ($p > 0.05$); 2. In all analyses, risk of hearing loss was significantly higher in subjects who did not always use ear plugs than in those who always used them; 3. Independent variables were more strongly associated with hearing loss in the right ear than with hearing loss in the left ear or hearing loss in either ear.

Although prevalence of hearing loss in this study was low, to reduce the burden of hearing loss in the future, hearing conservation programs, and safety and health education for industrial workers, would be desirable.

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

Academic Year: 2014 Advisor's Signature .....

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CHAPTER I
INTRODUCTION

1.1 Background and rationale

"Noise has been defined as unwanted sound" is different from sound. Sound is a sensory perception but noise refers to an undesired sound. When assessing impact of noise on human well-being, it can be classified as environmental noise which including noise in community, residential or domestic level such as traffic, playgrounds, sports, music and occupational noise which is noise in the workplace.

Occupational noise is associated with almost every work activity but some activities are associated with particularly high levels of noise such as working with impact processes, handling materials, or flying commercial jets. Highest risk works for hearing loss including those in manufacturing, transportation, mining, construction, agriculture and the military [1].

High level of occupational noise is a pervasive hazard with many adverse effects to human such as elevated blood pressure, sleeping difficulties, annoyance and stress, tinnitus, temporary threshold shift, and hearing loss. Hearing loss is the most serious health effect because it results from irreversible damage of hearing mechanism in the inner ear [2].

Hearing loss can be temporary or permanent. Temporary hearing loss results from short-term exposures to noise. After take a period of rest, normal hearing will return. If exposure to high noise level over a period of time, it is can cause gradually permanent damage [3].

Excessive occupational noise is a problem in all regions of the world. In the United States of America (USA), hearing loss is one of the most pervasive occupational health problems. Based on a National Institute for Occupational Safety and Health (NIOSH) survey in the 1980s on exposed workers in all economic sectors,

and on the 1992 Statistical Abstracts of the United States accounting production workers, revealed that there are approximately 30 million American workers have occupational noise levels [4].

In Europe, noise induced hearing loss is one of the most commonly reported occupational diseases. One in five of the workers must raise their voices to be heard when they are at work and 7% suffer from work related hearing difficulties. In United Kingdom, one of the most health problems is occupational deafness caused by exposure to high noise levels at work. It is estimated that more than 2 million people are regularly exposed to high noise levels over 85 decibel-A. Approximately 170,000 people suffer deafness, tinnitus, or other ear symptom. There are estimated 153,000 men and 26,000 women between 35-64 years old, who have severe difficulties in hearing attributable to noise in the workplace [5].

Hearing loss is the most common sensory impairment in people and affects more than 250 million people worldwide. In 2002, World Health Organization (WHO) estimated hearing loss is the 13th most frequent burden of disease in medium and high income countries, and hearing loss is projected to become among the top ten by the year 2030 [6].

In Thailand, noise-induced hearing loss has become a potentially large problem because many people migrated from rural areas to Bangkok and exposed to high noise level such as in traffic, construction and industry. The National Environmental Board of Thailand includes the study and control noise problems. Then recommend for limiting noise levels for various noise sources. Additionally damage compensation has been set up. However the problem is not yet solved because of poor public awareness of noise induced hearing loss and the difficulties to control noise [7].

Noise-induced hearing loss (NIHL) is one of the important occupational diseases which undergo surveillance by Bureau of the Occupational & Environmental Disease monitoring. In 2003, there are 1,839 companies that have high noise level

workplace. The number of workers exposed to high noise level and have a risk of noise-induced hearing loss are 116,462 persons. Most of them were found in central region [8].

During 2003-2009 Bureau of the Epidemiology, Department of Disease Control, Ministry of Public Health revealed that the number of workers who expose to occupational and environmental disease concerning with physical hazard are 128 persons and mostly 77 persons (60%) have noise-induced hearing loss [9].

The analyze of injury or occupational disease from Social Security Office, Ministry of Labor during 2008-2012 reported that there are 146,781 cases approximately affected by injury or occupational disease each year. The top 5 provinces which most workers had injury or occupational disease are Bangkok, Samutprakarn, Chonburi, Samutsakorn, and Pathumthani province respectively. The top 5 hazards which affect to injury or occupational disease are things or objects, machine, equipment, workplace environment, and vehicle respectively. The position which is affected the most by injury or occupational disease is operational industrial workers, as opposed to such positions as professionals and management [10].

In 2013, Bureau of Epidemiology revealed that hearing loss is one of the adverse health effects from physical hazard and occupation. 135 of patients who have hearing loss worked in high noise level area in a factory that are in food and beverage production 95 persons, machinery control 22 persons, truck and crane driver 14 persons, basic metal work 1 person, and other works 3 persons [11].

Regarding to Ministerial Regulations, no.9, Ministry of Industry B.E. 2535 (1992) and Notification no. 5/2535, Ministry of Public Health B.E. 2535 (1992) identified synthetic fiber factory (including polyester fiber factory) [12] that is a high noise level business and from the above problem, the researcher is interested in the studying in a polyester fiber factory. In the past much research has studied hearing loss in the textile industry, but not in polyester fiber workers although the polyester

fiber industry is an upstream business of textile industry and also has similar workplace environment.

From workplace noise level monitoring in this factory, the results showed that many workplaces have high noise level more than 85 dB(A) and workers must work during working hour in the area as a routine work. However there was no study of hearing loss of these workers in the past. So the researcher intends to assess this issue in a polyester fiber factory in Pathumthani province to find out the hearing loss-related burden of high noise level exposure. After this study, the result will be used to consider for occupational health improvement of these workers in the future.

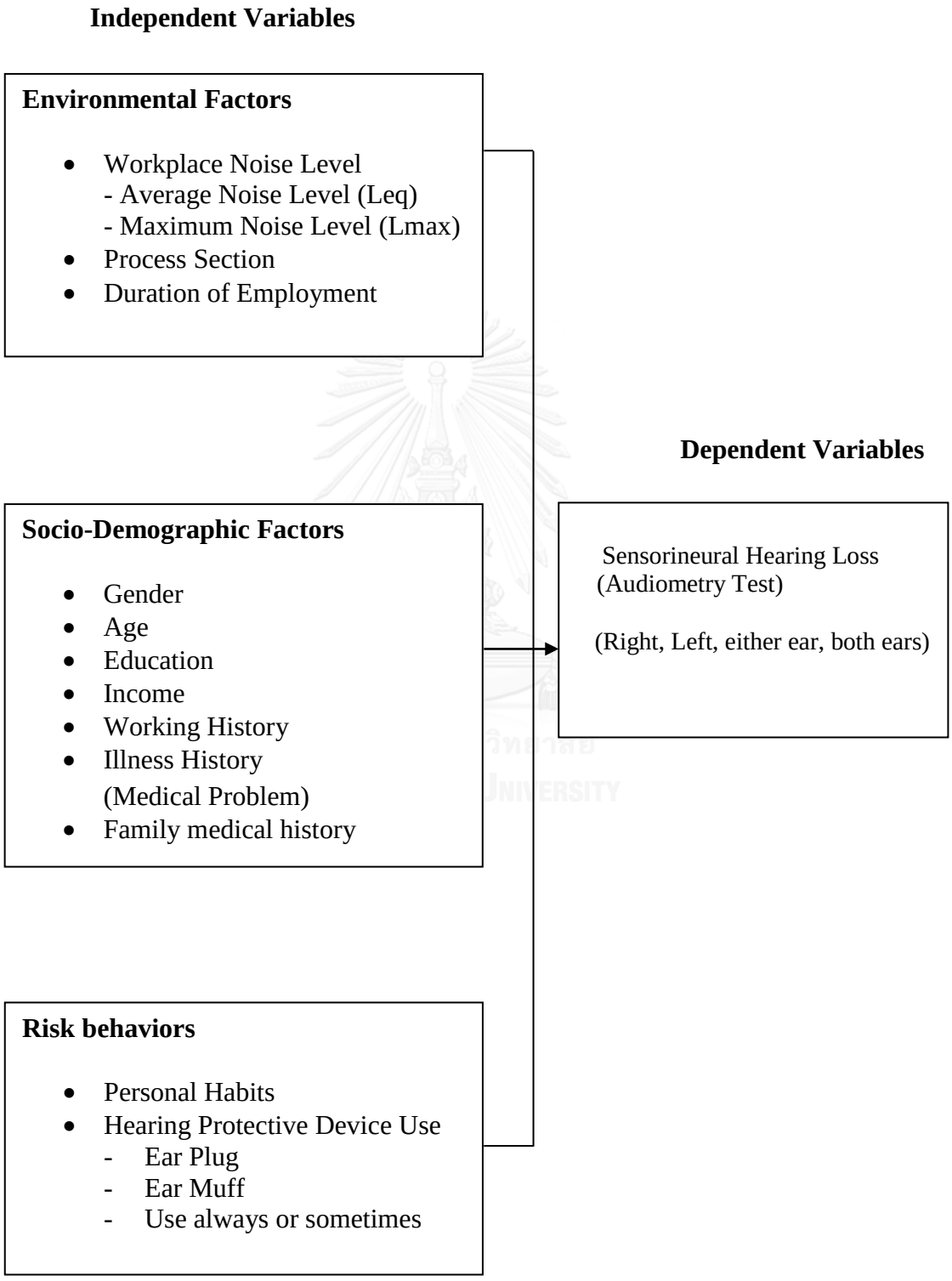
1.2 Research questions

- What is the prevalence of hearing loss among polyester fiber workers?
- What are the risk factors; environmental factor (e.g., noise level), socio-demographic characteristic and risk behavior, of hearing loss among polyester fiber workers? (as assessed in bivariate analysis)
- How is the association of noise level, environmental factor, socio-demographic characteristic and risk behavior, to hearing loss among polyester fiber workers? (as assessed in multivariable analysis)

1.3 Research objectives

- To characterize the prevalence of occupational hearing loss among polyester fiber workers
- To identify the risk factors of hearing loss (including noise level and other characteristics) among polyester fiber workers in bivariate analysis
- To identify the association between these risk factors and hearing loss among polyester fiber workers

1.4 Conceptual Framework



1.5 Operational Definition

Polyester Fiber Workers

: Refer to the regular or full time workers at operational and supervisory level both male and female who work in a polyester fiber factory that produces polyester fiber as a commercial product.

Hearing Loss

: The person who is not able to hear as well as someone with normal hearing. When perform audiometric testing by air-conduction and pure-tone, average hearing threshold level in either ear that equal or exceed 25 decibel at 500, 1000, 2000, 3000 Hz, or equal or exceed 45 decibel at 4000, 6000 Hz.

Environmental Factor

: Refer to workplace noise level both average sound level (Leq) and maximum sound level (Lmax), process section and employment duration of workers in a polyester fiber factory.

Socio-Demographic Factor

: Refer to gender, age, education, income, working history, illness history (medical problem), and family history (genetic) of the workers.

Risk Behavior

: Refer to the behavior that can effect to disease are personal habits, and hearing protective device (HPDs) uses.

CHAPTER II
LITERATURE REVIEW

2.1 Theoretical Overview

2.1.1 Introduction to Polyester Fiber Production

Polyester fiber factory produces polyester fiber from synthesized polymers. During in process, synthesized polymers will be formed as polyester fiber by pass through the major production processes that are polymerization, spinning and drawing process.

In a polymerization process, when raw materials (acid and alcohol) are reacted in a vacuum at high temperatures it results in condensation polymerization. After polymerization has occurred, the material is extruded onto a casting trough in the form of a ribbon. Then the ribbon will be cut into polymer chips by fast rolling cutter and effect to loud noise occurs.

Spinning process is a process to create polymer fibers. When polymer chip is sent into spinning process, it is melted by extruder then extruded by uses a spinneret. The polymer solidifies by cooling to form multiple continuous filaments. Before transfer polymer fibers to drawing process, the polymer fibers will be collected by fast spinning of rolling machine. Finally, the polymer fibers are transferred into drawing process and are drawn to increase strength and orientation by uses fast spinning of rolling machine.

As detail earlier in spinning and drawing process, loud noise is made from fast spinning of rolling machine that workers who work in the workplace are unavoidable.

Normally workers in cutter (polymerization), spinning and drawing process are a full-time Thai workers both male and female who has routine work as operating production, checking appearance of product at machine and take action to improvement during working hour.

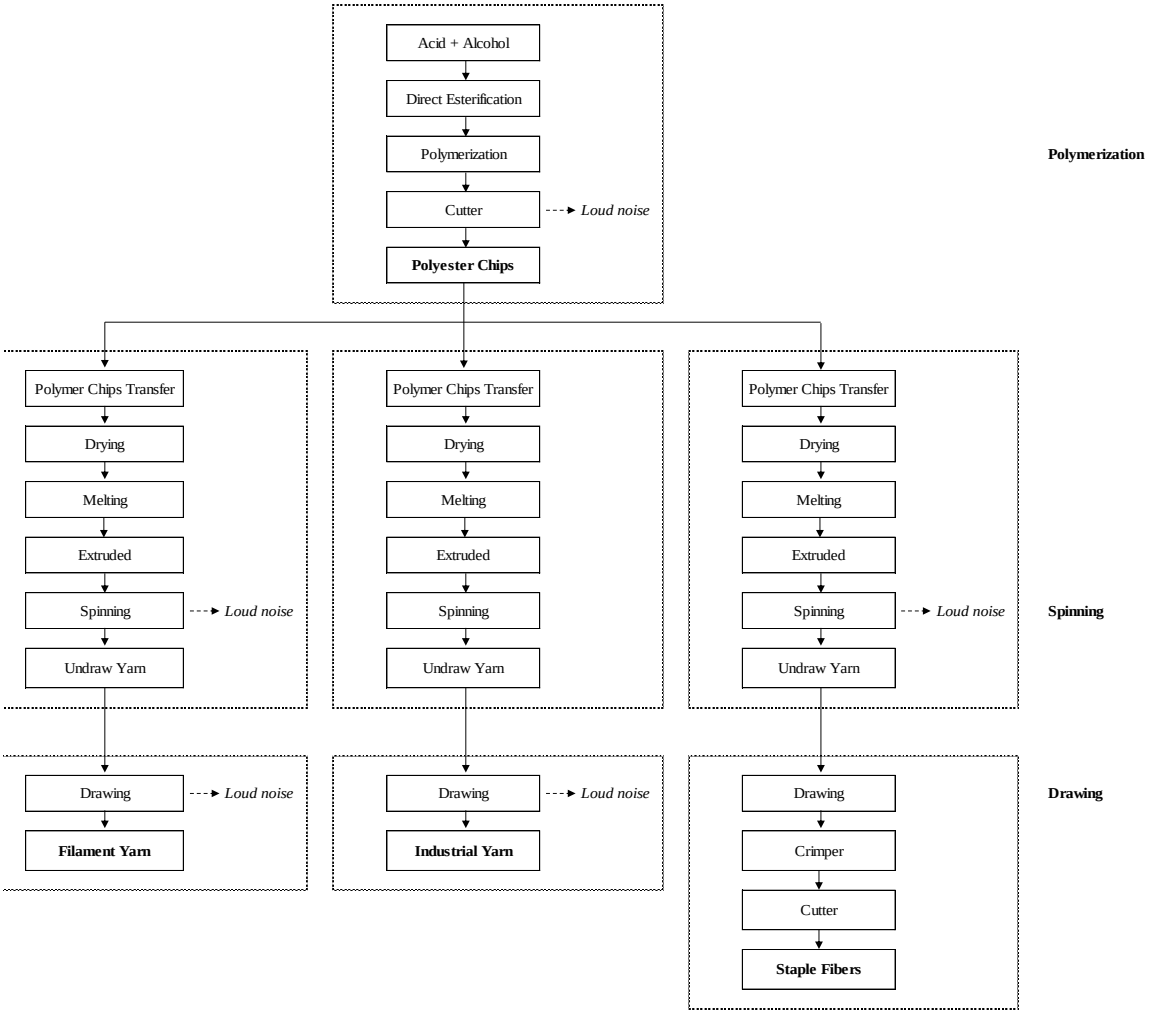


Figure 1 Flow chart of polyester fiber production and high noise level section

2.1.2 Occupational Hearing Loss

1) Hearing Mechanism

The human auditory system has three main auditory components and acoustic nerve (eighth cranial nerve). The outer ear gathers sound waves and transmits to the middle ear through the ear canal toward the eardrum, also called the tympanic membrane. The incoming sound waves vibrate the eardrum then transmits these vibrations to the inner ear, through the smallest bones in the middle ear which known as the ossicles including malleus, incus, and stapes. The middle ear consists of a small air-filled chamber and connects to the throat via eustachian tube. The inner ear has two parts which include the vestibular system and the cochlea. The vestibular system is an organ of balance and is primarily responsible for detecting movement of the head and to a lesser extent. The cochlea is a spiral-shaped and fluid-filled tube. It contains thousands of delicate hair cell (or auditory sensory cells) in the organ of Corti. There are two types of hair cells; inner and outer hair cells. When the sound waves enter to the inner ear, the outer hair cells will amplify sound vibrations. Then the inner hair cells convert these vibrations into electrical signals and send the signals to the brain through the auditory nerve. Finally the brain will translate the signal into sound.

However the hair cells of the organ of Corti can be damaged by many factors such as aging, loud noise, ototoxic chemicals, or ototoxic medications [13].

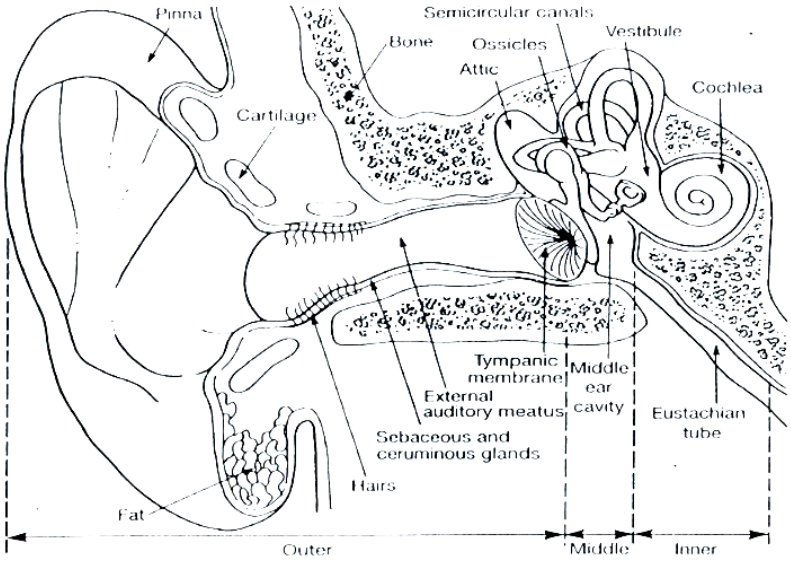


Figure 2 The outer, middle, and inner ear [14]

2) Type of Noise

Continuous noise is noise which remains constant and stable over a given time period. Continuous noise can be classified to steady-state noise and non-steady-state noise. Steady-state noise is noise level which does not change more than 3 dB at given place and period of time such as noise from weaving machine, spinning machine, or fan. Non-steady-state noise is noise level which changes more than 10 dB at given place and period of time such as noise from grinding machine, or circular saw.

Intermittent noise is non-continuous noise. There is mix of relatively quiet and noisy periods such as noise from air pump, traffic, or an airplane.

Impact or impulse noise is a very short burst of loud noise which lasts for less than one second and there is noise changes more than 40 dB such as noise from foundation piling, or pressing machine [15].

3) Types of Hearing Loss

Hearing loss can be caused by many different causes. Some types of hearing loss can be successfully treated with medicine or surgery. There are three basic types of hearing loss: conductive hearing loss, sensorineural hearing loss, and mixed hearing loss.

Conductive hearing loss affects the outer ear and middle ear including the pinna, ear canal, eardrum, and the cavity behind the eardrum. It occurs when sound is not conducted efficiently through the outer ear canal to the ear drum, and the ossicles of the middle ear. Conductive hearing loss usually involves a reduction in sound level or the ability to hear light sounds. There are various possible causes of conductive hearing loss with the most common including cerumen impaction, middle ear infections, and eardrum perforation.

Sensorineural hearing loss affects the inner ear (sensory) or the auditory nerve that connects the inner ear to the origin of the nerve in the brain. It occurs when there is damage to the inner ear, or to the nerve pathways to the inner ear to the brain. Most of time, sensorineural hearing loss cannot be medically or surgically corrected. Sensorineural hearing loss is the most common type of permanent hearing loss. Sensorineural hearing loss reduces the ability to hear light sounds. Although speech is loud enough to hear, it may still be unclear, or sound muffled. There are various possible causes of sensorineural hearing loss such as aging (presbycusis), head trauma, illnesses such as diabetes or cardiovascular disease, drugs that are toxic to hearing (ototoxic drugs) such as aminoglycosides or cisplatin, genetic, malformation of the inner ear, and exposure to loud noise.

A hearing loss is classified as mixed hearing loss when there is the combination between conductive hearing loss and sensorineural hearing loss. There may be damage in the outer or middle ear and in the inner ear, or auditory nerve [13].

4) Histopathology of Occupational Hearing Loss

Exposure to loud noise for a brief time or in a long time, it can damage sensitive structure in the inner ear and causes hearing loss. Exposure to loud noise can result in temporary threshold shift (TTS) or permanent threshold shift (PTS) and it can affect one ear or both ears. Moderate exposure in a short time period can cause temporary threshold shift. Hearing loss after temporary threshold shift may fully recover within 24 to 48 hours but hearing loss after permanent threshold shift is irreversible. Noise-induced hearing loss differs from occupational acoustic trauma that is a sudden hearing loss from single exposure to a very short impulse noise such as gun shot or explosion.

Long time exposure to noise leads to damage and loss of hair cells in the organ of corti, which is contained in cochlea. These sensory hair cells and surrounding structures are vibrated by incoming acoustic signals then convert this vibration into electrical signals to be firings of the eighth cranial nerve fibers. Chronic exposure to loud noise (sound level above 85 decibel-A) initially damages the outer hair cells which are responsible for high frequency sounds (3,000-6,000 Hertz range).

Long time continued exposure to high noise level may lead to impair transmission of both low and high frequency sounds to the brain. If the length of exposure and intensity of noise increase, damage in sensory organ also increases and eventually becomes irreversible. Particularly cochlear blood flow may be impaired, hair cells become fused into giant cilia or disappear, hair cells and supporting structures disintegrate, and finally the nerve fibers that innervated the hair cells disappear [13].

5) Sign and Symptoms of Occupational Hearing Loss

Symptoms of possible noise-induced hearing loss includes transient tinnitus (ringing, buzzing or roaring in the ears or head), a feeling that the ears are plugged up, or sound muffled after exposure to loud noise. People who expose to noise-induced

hearing loss often notice difficulty understanding conversation especially in unfavorable listening conditions. Any level of noise-induced hearing loss may muffle high frequency sounds such as buzzers of whistles, and may result in difficulty discriminating speech consonant sounds. People with noise-induced hearing loss are likely to have more difficulty than expected in ideal face to face communication situations. As noise-induced hearing loss is inner ear damage, so it lacks overt symptoms such as pain, bleeding, or easily noticeable deformity [13].

6) Causes of Hearing Loss

Intensity of Sound (Loudness)

Intensity of sound is measured in decibels (dB). The scale runs from the faintest sound the human ear can detect; 0 decibels, to over 180 decibels, the noise of a rocket pad during launch. Higher intensity of sound can cause more damage. Many experts agree that continual exposure to a sound more than 85 decibels may become dangerous [16].

Table 1 Decibel levels and effects on the hearing mechanism

Approximate Sound Level	Physiological Response	Example of Noise Source
0 dB	Threshold of hearing	Anechoic Chamber
30 dB	Undisturbed sleep	Average bedroom
50 dB	Hearing with comfort	Urban noise level away from roads
60 dB	Difficulty understanding conversation on telephone	Busy office
70 dB	Damage to hearing is unlikely to occur	Assembly work without noisy tools
85 dB	Some hearing damage after 8 hours	Noise in a very busy street
100 dB	Some hearing damage after	Grinding metal, noisy lawn

	approximately 15 minutes	mower
115 dB	Some hearing damage after approximately 30 seconds	A power saw or a chain saw operating
130 dB	Threshold of pain	A jet aircraft taking off
140 dB	Damage over a brief period of time	A rifle being fired
150 dB	Instantaneous damage	An explosion, heavy-caliber weapon

Frequency of Sound (Pitch)

Frequency is measured in cycles per second, or called Hertz (Hz). The higher the pitch of the sound is the higher the frequency. A person who has hearing within the normal range can hear sounds at the frequencies between 20 and 20,000 Hertz. Noise-induced hearing loss generally occurs at a pitch of about 2,000 to 4,000 Hertz. When hearing impairment begins, the high frequencies are often lost first. High frequency hearing loss can distort sound so that speech is difficult to understand although it can be heard [16].

Duration

Duration or amount of time exposed to a loud noise, can affect the extent of noise-induced hearing loss. The longer exposure to a loud noise, the more damaging it may be [16].

Aging

Age-related hearing loss occurs gradually over time because of various changes in the nerves and cells of the inner ear such as changes in the structures of the inner ear, changes in blood flow to the ear, impairment in the nerves responsible for hearing, changes in the way that the brain processes speech and sound, or damage to the tiny hairs in the ear that are responsible for transmitting sound to the brain [16].

Solvents Exposure

Solvents exposure can have an adverse effect on the auditory and vestibular systems in human. Many studies in human demonstrated an ototoxic effect of organic solvents such as toluene, xylene, or styrene in agriculture, oil and gas extraction, construction, transportation, electric and gas services, automotive dealers and repair services, gasoline service stations and a wide range of manufacturing industries such as textiles, paper products, printing and publishing [16].

Ototoxic Medication

Ototoxic medicines are the medicines that damage the ear and cause hearing loss. They are a common cause of hearing loss especially in older adults who have to take medicine regularly. Hearing loss in most cases, occur because the medicine damages the cochlea in the inner ear. Hearing loss caused by an ototoxic medicine tends to develop quickly. The first symptoms usually are ringing in the ears (or tinnitus) and vertigo. Hearing will returns to normal after stop taking the medicine but some medicines can cause permanent damage to the inner ear. This results in permanent hearing loss although stop taking the medicine. Medicines may cause hearing loss such as aminoglycoside antibiotics (antibacterial agents) such as kanamycin, neomycin and antineoplastic agents [16].

Smoking

Smoking has been shown to have adverse effects on hearing**.** Various studies showed that smokers are 70% more likely to develop some form of hearing loss than non-smokers because of every draw, a plethora of toxic chemicals are ingested such as formaldehyde, arsenic, vinyl chloride, ammonia and hydrogen cyanide which known as “ototoxic”, that can impair hearing, cause tinnitus, or affect body balance [16].

7) Impact of Hearing Loss

Hearing loss can impact human life in many ways. People may be less able to understand conversation or appreciate music. A ringing in the ears (or tinnitus) usually occurs after noise exposure and becomes permanent. Some people react to loud noise with anxiety and irritability, increase in pulse rate and blood pressure, or increase in stomach acid. Expose to very loud noise also reduces efficiently in performing difficult tasks by diverting attention from the job [13].

8) Audiometric Characteristics

Audiometric characteristics in noise-induced hearing loss generally show a sharp depression at high frequencies between 3 kHz and 6 kHz while the primary speech frequencies (0.5-2 kHz) are normal. Noise-induced hearing loss affects the higher frequencies which begin typically around 4 kHz or 6 kHz and creating notch or V-shape dip because these two audiometric frequencies are most often affected by noise. After higher frequency hearing loss progresses, the deterioration of hearing loss at lower frequencies will follows. So hearing loss at lower frequencies (0.5-2 kHz), take longer time to be affected by noise than higher frequencies (3-6 kHz). If continued exposure to noise for a long period of time, damage will occur both higher and lower frequencies of noise, so that the notch will gradually flatten. However in advanced cases of noise-induced hearing loss, the audiogram begins to slope downwards at frequencies as low as 0.5 kHz [13].

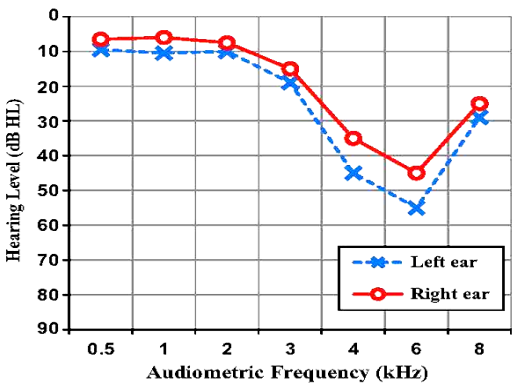


Figure 3 Typical audiometric pattern of noise-induced hearing loss [13]

9) Prevention of Hearing Loss

As described earlier, exposure to loud noise can cause sensorineural hearing loss that is an irreversible condition because of damaged hair cells without regenerate. Noise-induced hearing loss is largely preventable. Periodic audiometric tests can detect hearing loss and prevent further loss. The Occupational Safety and Health Administration (OSHA) identified that annual audiometric test must be provided in hearing conservation program.

When consider serious impact on worker's quality of life, noise-induced hearing loss should be prevented with an effective occupational hearing conservation program. OSHA (29 CFR 1910.95) identified that the employer shall provide a continuing and effective hearing conservation program whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale. This hearing conservation program must incorporate five factors; (1) periodic noise exposure monitoring, (2) engineering and administrative controls, (3) personal hearing protection, (4) audiometric evaluations and follow up activities, and (5) education and training management of employee. However this requirement is primarily for manufacturing sectors but not currently apply to some sectors such as fire services, construction, and agriculture [13].

10) Hearing Protective Devices

Although reduction of noise emission from noisy machinery or equipment through engineer controls is the best way for occupational hearing loss prevention. In fact, these controls are often impractical, costly, or scientifically impossible to fully achieve. As standard of the OSHA (29 CFR 1910.95), if administrative or engineering controls could not reduce sound levels effectively, hearing protective devices (HPDs) such as ear plugs or ear muffs shall be provided and used to reduce sound levels within the levels as identified

Ear plugs are small inserts to fit into the outer ear canal. Ear plugs must block the ear canal with airtight seal completely to be effective to use. They are available in a variety of shapes and sizes to fit ear canals and can be custom made.

Earmuffs are a device that can fit over the entire outer ears to block the ear canal with airtight seal completely. When wearing earmuffs, it cannot seal around eyeglasses or long hair, so the adjustable headband tension must be sufficient to hold earmuffs firmly around the ear.

Much research has demonstrated that using of HPDs is effective for occupational hearing loss prevention. In order to prevent occupational hearing loss effectively, workers must use HPDs continuously when noise levels are high. However research shows that workers do not use HPDs continuously. Therefore it is important to develop and implement effective intervention programs to promote the HPDs using of workers [13].

11) Definition of Hearing Loss

There is a diversity of hearing loss definition which many studies refer in different such as the definition from World Health Organization (WHO). WHO classified hearing impairment ranges from “no impairment” to “profound impairment” according the threshold level. The hearing threshold level, using audiometry, is to be taken as the better ear average for four frequencies 0.5, 1, 2, and 4 kHz. (3) The different grades of hearing impairment and their impact in performance are presented in Table 2.

Table 2 WHO grades of hearing impairment [17]

Grade of Impairment	Audiometric ISO Value (average of 500, 1000, 2000, 4000 Hz)	Impairment Description
0 (no impairment)	25 dB HL or less (better ear)	No or very slight hearing problems. Able to hear whispers
1 (slight impairment)	26-40 dB HL (better ear)	Able to hear and repeat words spoken in normal voice at 1 meter
2 (moderate impairment)	41-60 dB HL (better ear)	Able to hear and repeat words using raised voice at 1 meter
3 (severe impairment)	61-80 dB HL (better ear)	Able to hear some words when shouted into better ear
4 (profound impairment including deafness)	81 dB HL or greater (better ear)	Unable to hear and understand even a shouted voice

Hearing loss was also defined by American Medical Association (AMA)/AAO as an average hearing threshold in either ear for the frequencies of 500, 1000, 2000, and 3000 Hz that exceeded 25 dB [18].

In Thailand, there is the guideline of hearing loss from Bureau of Epidemiology, Ministry of Public Health; 1) If an average hearing threshold level in either ears that less than 25 decibel across frequencies at 500, 1000, 2000, 3000, 4000, 6000 Hz, hearing is normal 2) If an average hearing threshold level in either ears that equals or exceeds 25 decibel across frequencies at 500, 1000, 2000, 3000, 4000, 6000 Hz, hearing is surveillance level 3) If an average hearing threshold level in either ears that equals or exceeds 25 decibel at 500, 1000, 2000, 3000 Hz and equals or exceeds 45 decibel at 4000, 6000 Hz, hearing is impairment [12].

12) Standard of Occupational Noise Level

In the United States, the National Institute for Occupational Safety and Health (NIOSH) recommended the standard for announcement by regulatory agencies such as Occupational Safety and Health (OSHA). The NIOSH recommended exposure limit (REL) for occupational noise exposure is 85 dB(A) as 8-hr time-weighted average (TWA) and using 3-dB exchange rate (An increment of decibels that require the halving of exposure time). If exposure at or above 85 dB(A), will be considered hazardous. The ceiling limit of exposure to continuous, intermittent, or impulsive noise shall not over 140 dB(A) [19].

OSHA is a part of the United States Department of Labor and is responsible for developing and enforcing workplace safety and health regulations. The OSHA standard (29 CFR 1910.95) is the law that forces employers in the industrial sector to follow it. OSHA permits exposures of 85 dB(A) for 16 hours per day, and uses a 5-dB exchange rate. Comparison of duration hours of allowable exposures based on OSHA and NIOSH criteria are shown in Table 3 [20].

Table 3 Comparison of duration hours of allowable exposures based on OSHA and NIOSH criteria

Noise Level dB(A)	85	88	90	92	94	95	100	105	110	115
OSHA PEL	16		8			4	2	1	0.5	0.25
NIOSH REL	8	4			1		0.25			

Remark : PEL = Permissible Exposure Limit; REL = Recommended Exposure Limit

In Thailand, standard of occupational noise level were specified by Ministry of Industry and Ministry of Labor. The notification of Ministry of Industry, B.E. 2546 (2003) and The Ministerial Regulation of Ministry of Labor, B.E. 2549 (2006) limit noise average 8 hours shall not exceed 90 dB(A) and noise max level shall not exceed 140 dB(A). The permissible exposure limit of noise level shall not exceed the value as in Table 4 [21] [22].

Table 4 Permissible exposure limit of noise level for working

Working hours per day	Noise level (time-weighted average)
12	87
8	90
6	92
4	95
3	97
2	100
1 ½	102
1	105
½	110
¼ or less	115

Remark : If working hours are not comply with the standard, the permissible exposure limit of noise level shall be calculated by;

$$T = \frac{8}{2^{(L-90)/5}}$$

T = Permissible of working hours (hr)

L = Noise level [dB(A)]

If noise level from calculation has decimal point, the decimal point shall be deleted

In case of noise level exceed than the standard limit, employer must improve noise source, or noise pathway for protection employee do not expose noise level over the standard. If the employer could not improve as mentions, the employer must provide appropriately hearing protective devices (HPDs) for the employee to use during working hour [21] [22].

2.2 Review of Related Literature

Most of the textile factories in developing countries are facing the problem of noise pollution like Tanzania. The study in a textile mill revealed that around 30% of workers worked in noisy areas where noise levels are equal or greater than 90 decibel(A). The highest noise levels were found at the loom shed, the ring frame, and the carding area [23].

Many studies have been carried out in the textile factories in developed countries. Two textile plants in India reported that noise level in some sections such as the loom shed, spinning, and ring frame area is more than the acceptable limit 90 decibel(A) for 8 hours exposure limited by OSHA. However the results of the interview questionnaire revealed that high noise level causes speech interference 70% of workers and 42% workers reported that noise to be annoying [24].

The study in textile factory in Jordan demonstrated that the prevalence of hearing loss was higher in the exposed group 30% and 8% in the non-exposed group. Hearing loss progresses rapidly during 8-10 years of exposure. The increasing of hearing loss prevalent rate depends on level of noise and the duration of employment [25].

The study in Vietnam studied in the weaving section of textile factory. The studied showed that noise levels in the weaving section exceeded the Vietnamese standard which specified 90 decibel(A). The workers with more than 10 years of noise exposure had the worst hearing threshold levels when compared to those employed in a shorter period of time. Hearing impairment also related to the workers who were more than 35 years old [26].

As the study in a textile factory in Turkey which observed that the textile workers in weaving section exposed to hearing loss especially who worked in the noise levels area at 95 decibel(A) or more when compared to the group that did not exposed to any noise. It also observed that the workers with longer employment

duration had poorer hearing threshold when compare to the group with shorter employment. Hearing loss had started on the workers who had worked for 5-8 years [27].

The textile industries in Pakistan, it has been shown that the weaving section has a highest noise level same as most of studies conducted worldwide. It found that noise levels in the range 88.4-104 decibel(A). The result showed 92.7% of the workers were aware that high level of noise can interrupt speech communication. 54.8% of the workers used ear protection devices. It also found that hearing loss was significantly associated with working experience of more than 10 years [28].

The study in Thailand, 1989 revealed that textile industry is one of the major businesses for export purposes in Thailand. Noise is one of the major threats to textile workers and affect to hearing loss. The result of this study showed that the symptom frequency of workers in textile factory in Samut Prakan province relating to noise exposure was higher in the weaving sections and the average noise level in the weaving section was 101.3 +/- 2.7 decibel(A). The result of audiometric tests showed the significantly higher noise-induced hearing loss among workers in the weaving section when compared to the workers in other sections ($P<0.01$) and hearing levels decreased with longer years of working experience [29].

A case study of industrial bottling workers, Thailand in 1995 reviewed that the noise level in the studied factory was 101 dB(A). The study also compared the hearing loss between the studied workers and the workers who work in low noise level workplace (control group). The results found that the studied worker had more hearing loss significantly ($p<0.05$) [30].

The study on noise level and hearing threshold of state railway drivers in Thailand, 1998 showed that average noise level in diesel locomotive driver rooms from Bangkok to Chaingmai and Chaingmai to Bangkok were 85.42-88.00 and 84.37-86.28 dB(A), respectively. From 138 diesel locomotive driver, 95 persons (68.8%)

had abnormal hearing at frequency 4,000-8,000 Hz. It was also found that age and duration of work had a positive relationship with level of abnormal hearing [31].

In Thailand 1999, the study found that noise level in jute mill which workers must work duration 8 hours per day was 82.0-103.4 dB(A). Among total 247 workers, most of them were female (94.7%), age between 36-40 years (35.2%), duration of work experience more than 21 years (25.5%). The prevalence of hearing loss was 76.5% and 52.6% were hearing loss at high frequency. Most of them were hearing loss at frequency 6,000 Hz [32]

The study in plastic container factory, Thailand in 2000 stated that noise level in the studied area was between 87.2-91.5 dB(A) and the workers worked 8 hours per day. Found 49 persons (72%) from total 68 persons of female workers had abnormal hearing performance. The most hearing loss (75.6%) of abnormal workers was at frequency 6000 Hz. Statistical analysis showed that ages and working time of the worker affected the hearing loss significantly ($P<0.05$) [33].

The study in a large food canning factory in Chaingmai province, Thailand in 2004 revealed that prevalence of hearing loss of workers was 21.0%. It was found that 51.1% of the studied workers used hearing protective devices (HPDs) and 48.9% of them never used HPDs. Among the workers who used HPDs, 28.9% used HPDs all the time while exposed to high noise level and 71.1% used HPDs occasionally. It was also found that correlation between correctly of using HPDs and hearing loss was significant ($P<0.05$) [34].

Result from the study in 3 Discotheques in Phitsanulok province in Thailand, 2005 found that average of noise level during 7 hours was between 95.4-98.3 dB(A). 62.34% of Discotheque employees were exposed to abnormal hearing. Employee between age 35-41 years were the most percentage of hearing loss (80.0%). The results showed that noise level in workplace, used of hearing protective devices (HPDs), and working history were correlate with hearing loss significantly ($P<0.05$) [35].

The study in 16 industrial factories which had noise level in workplace more than 85 dB(A) in Songkhla province, Thailand in 2008 found that prevalence of hearing loss of workers 358 persons was 20.11%. The major risks of hearing loss were being male, age more than 40 years, factories medium size, and factories small size (95% CI) [36].

CHAPTER III
MATERIALS AND METHODS

3.1 Research design

Research design of this study is cross–sectional study to assess prevalence of occupational hearing loss among polyester fiber workers and risk factors associated with occupational hearing loss.

3.2 Study area

This study was conducted in a polyester fiber factory in Pathumthani province which produces polyester fiber as a commercial product. The study areas are high noise level area more than 85 dB(A) which workers must work during working hour as a routine work and there was no study of hearing loss of these workers in the past. These study areas are cutter, spinning, and drawing process.

3.3 Study population

The populations of this study are all workers of a polyester fiber factory in Pathumthani province who are working in high noise level area more than 85 dB(A) during working hour total 130 persons.

Inclusion Criteria

1. Full-time Thai male or female workers in a polyester fiber factory in Pathumthani province
2. The workers who have duration of employment more than 1 year
3. The workers who work in different locations that are cutter section, spinning section, and drawing section

Exclusion Criteria

1. The workers who had head trauma or medical problem in the past
2. The workers who refuse to participate in the study

3.4 Sampling technique

All 130 workers of a polyester fiber factory in Pathumthani province who are working in cutter, spinning, and drawing section were invited to participate in the study. Thus, no sample size calculation was done. In this study, the participants have rights to withdraw at any time.

3.5 Sample & sample size

The objectives of the study are to study prevalence of occupational hearing loss among polyester fiber workers and association between socio-demographic and risk behavior. So this study was conducted on the full-time Thai workers both male and female from cutter, spinning and drawing process in a polyester fiber factory, Pathumthani province total 130 persons.

3.6 Measurement tools

Workplace noise level monitoring

Workplace noise level was monitored by third party (registered company to Department of Industrial Work, Ministry of Industry) 1 time per year, in 2011, 2012, 2013, and 2014, as Ministry of Labor's regulation, Thailand B.E. 2549 (2006). Level of workplace noise was monitored by sound level meter (Model 2127, ACO, Japan) on A-weighting during 8 working hours at the height same as human ear level (1.5 meter from floor) total 5 areas that are in cutter, spinning and drawing process.

Audiometry test

For audiometry measurement, was performed by licensed audiologist from the hospital to follow Ministry of Labor's regulation, Thailand B.E. 2547 (2003). Audiometry test measured the threshold of hearing each ear, by a pure-tone air conduction at frequencies 500, 1000, 2000, 3000, 4000, and 6000 Hz respectively. Then interpretation of the data was conducted. If an average hearing threshold level in either ears that equals or exceeds 25 decibel at 500, 1000, 2000, 3000 Hz and equals or exceeds 45 decibel at 4000, 6000 Hz [12], the test was interpreted as hearing loss. Audiometry was done in all 4 years, but quality control was adequate only in 2014. Thus, hearing loss was analyzed only for 2014.

Questionnaire

This study collected the data by using an interview questionnaire. The questionnaire follows the Guidelines of Hearing Loss Monitoring from Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, 2004. Before collecting the data, the questionnaire was reviewed by three experts to verify validity (index of consistency: IOC). The questionnaire consists of 3 major parts ; Part I : Socio-demographic characteristics and working history, Part II : Personal health and risk behavior, and Part III : Hearing protective device uses.

Pilot study

After reviewed the questionnaire by three experts to verify validity (index of consistency: IOC) and revised for appropriate, a pilot study was conducted to verify reliability with 30 workers in a Polyester Fibers factory in Ayutthaya province. The draft had administered to these workers. The reliability value of Cronbach's alpha coefficient of the questionnaire was 0.785. Then revise the questionnaire for clarity as appropriate and full scale study in Pathumthani province was conducted.

3.7 Data collection

In data collecting process, the researcher received permission from the owner factory to collect the data and use secondary data. Workplace noise monitoring result and audiometry test were considered at secondary data of the factory for 1 year. Noise measurements were made in April 2014. Audiometry was done in September 2014. (Noise levels and audiometry results are also available for 2011 through 2013. These will be considered in secondary analyses).

The questionnaire of the study was developed by expert-review method and applied to the participants with researcher and 2 researcher assistants (interviewers) who are public health officers by face-to-face interviews. Before the interview, the interviewers were trained by the researcher to ensure understanding interview method. The interview method was conducted during weekdays in May-June 2015 and take 1 time around 10 minutes per person.

The content of questionnaires are include Part I : Socio-demographic characteristics and working history, Part II : Personal health and risk behavior, and Part III : Hearing protective device uses.

3.8 Data analysis

Descriptive statistics was used to measure both independent variables: workplace noise level, socio-demographic characteristic and risk behavior, and dependent variable: hearing loss. Therefore present by central tendency (mean, median), frequency, min-max, standard deviation, and percentages.

Fisher ‘s exact test was used to evaluate the relationship of each independent variable; workplace noise level, socio-demographic characteristic and risk behavior, separately with dependent variable; hearing loss.

For estimating the association of workplace noise level, socio-demographic characteristic and risk behavior with hearing loss, will use multiple logistic regressions analysis. The multiple logistic model included variables for which $p<0.2$ in bivariate analysis.

Statistical analysis of this study will be performed by using the SPSS statistical package (version 16.0 IBM Corporation; NY, USA) and was done by cross-sectional study design among workers in a polyester fiber factory.

All the statistical analyses will be based on a statistical significance level equal to 0.05 or less.

3.9 Ethical consideration

For the beginning of this study, the proposal and research instrument is reviewed by Ethical Review Committee, Chulalongkorn University to ensure that the questionnaire excludes any sensitive issue which is ethically incorrect. Before conducts the data collection by questionnaires, all the participants are appropriately informed about purposes, method and importance of this study. The questionnaires identified employee number to comply the audiometry test result (no need employee name). The questionnaires were distributed by a research team with confidentially. The secured of their information were ensured and data is strictly used only for the study purposes that are mentioned in the consent form. Additionally the research team records the responds consent from the participants in the questionnaire.

CHAPTER IV
RESEARCH RESULTS

This research is the cross-sectional study to assess prevalence of occupational hearing loss among polyester fiber workers and risk factors associated with occupational hearing loss. The study was conducted in a polyester fiber factory in Pathumthani province. The study areas are high noise level area more than 85 dB(A) which workers total 130 persons must work during working hour. These areas are cutter, spinning, and drawing process. After interview by questionnaire, there are 119 persons included in the study.

This chapter presents the research results by dividing into two parts; descriptive part and analytical part. The descriptive part presents workplace noise level characteristics and frequency distributions of socio-demographic and risk behavioral characteristics (independent variables). The descriptive part also presents prevalence of hearing loss or auditory symptoms in the preceding 3 months (dependent variables).

The analytical part presents associations between independent variables and prevalence of hearing loss in 2014. It also presents a summary of directions of statistically significant associations between independent variables and prevalence of hearing loss.

Part 1 : Descriptive part

4.1 Workplace noise level characteristics

Workplace noise level characteristics total 5 areas located in cutter, spinning, and drawing process. The average 8 hours of noise level all areas was between 67.8-92.0 dB(A). The maximum noise level was between 86.0-105.8 dB(A). The results or workplace noise level in year 2014 are shown in Table 5.

Table 5 Workplace noise level characteristics in year 2014

Area	Average 8 hr [dB(A)]	Max [dB(A)]
Polymerization process		
- Cutter section	67.8	86.0
Filament yarn process		
- Spinning section	90.9	101.1
- Drawing section	92.0	99.6
Industrial yarn process		
- Drawing section	83.1	99.5
Staple fiber process		
- Spinning section	88.2	105.8
Standard	**90.0**	**140.0**

4.2 Frequency distribution of socio-demographic characteristics

From the workers total 119 persons who work in cutter, spinning, and drawing section. Male and female number are 53 persons (44.5%) and 66 persons (55.5%) respectively. Most age of workers are in a range 40-49 years old (55 persons, 46.2%), mean = 40.6, median = 41.0, minimum age = 24, and maximum age = 55 years old. Most workers graduate from high school or vocational certificate (103 persons, 86.6%). Almost workers get an income more than 10,000 Baht per month (118 persons, 99.2%). Most workers have working experiences more than 20 years (50 persons, 42.0%), mean = 17.9, median = 18.0, minimum year = 1, and maximum year = 37. Most workers have working hour 6-7 hours per day (64 persons, 53.8%), and no

working experience in the past (109 persons, 91.6%). The frequency distribution of socio-demographic characteristics is shown in Table 6.

Table 6 Frequency distribution of socio-demographic characteristics

Characteristics	Number (n = 119)	Percentage %
Section		
Polymerization : Cutter Section	13	10.9
Filament Yarn : Spinning Section	21	17.6
Filament Yarn : Drawing Section	59	49.6
Industrial Yarn : Drawing Section	14	11.8
Staple Fiber : Spinning Section	12	10.1
Sex		
Male	53	44.5
Female	66	55.5
Age		
Mean 40.6, Median = 41.0, SD = 7.59, Min = 24, Max = 55		
20-29 Years old	9	7.6
30-39 Years old	39	32.8
40-49 Years old	55	46.2
50-59 Years old	16	13.4
Education		
Primary school	4	3.4
High school or vocational certificate	103	86.6
Diploma or high vocational certificate	6	5.0
Bachelor’s degree or higher	6	5.0

Income		
Less than 10,000 Baht per month	1	0.8
Equal or more 10,000 Baht per month	118	99.2
Working duration		
Mean 17.9, Median = 18.0, SD = 9.73, Min = 1, Max = 37		
1-5 years	18	15.1
6-10 years	14	11.8
11-20 years	37	31.1
20 years up	50	42.0
Working hour per day		
6-7 hours	64	53.8
8 hours up	55	46.2
Working history		
Yes	10	8.4
No	109	91.6

4.3 Frequency distribution of personal behavior

The result from questionnaires shows that most of workers have never listened to a song by headphones (85 persons, 71.4%) and never go to discotheque, pub, or karaoke (96 persons, 80.7%). All workers used hearing protective devices (HPDs) which most are ear plug-foam (104 persons, 87.4%). Most workers use HPDs every times during work (89 persons, 74.8%). The frequency distribution of personal behavior is shown in Table 7.

Table 7 Frequency distribution of personal behavior

Characteristics	Number (n = 119)	Percentage %
Listen to a song by headphones		
Every day	4	3.4
Every week	6	5.0
Less than 1 time per week	24	20.2
Never	85	71.4
Go to discotheque, pub, karaoke		
Every week	1	0.8
Every month	1	0.8
Less than 1 time per month	21	17.6
Never	96	80.7
Hearing protective device (HPDs) uses		
Yes	119	100.0
No	0	0
Type of hearing protective device (HPDs)		
Ear plug : foam	104	87.4
Ear plug : silicone	15	12.6
Ear muff	0	0
How often to use hearing protective device (HPDs)		
Use every times during work	89	74.8
Use sometimes during work	30	25.2
Never use	0	0

4.4 Prevalence of auditory symptoms

The result of auditory symptoms in preceding 3 months at either ear or both ears show the prevalence of fullness ear 18.5% (22 from 119 persons), and prevalence of tinnitus 5.9% (7 from 119 persons) as detail in Table 8.

Table 8 Prevalence of auditory symptoms

Characteristics	Number (n = 119)	Percentage %
Fullness ear		
Yes	22	18.5
No	97	81.5
Tinnitus		
Yes	7	5.9
No	112	94.1

4.5 Prevalence of hearing loss

The result of hearing test in either ear or both ears show that prevalence of hearing loss is 7.6% (9 from 119 persons) as detail in Table 9.

Table 9 Prevalence of hearing loss

Characteristics	Number (n = 119)	Percentage %
Hearing capacity		
Normal	110	92.4
Hearing loss	9	7.6

Part 2 : Analytical part

4.6 Association of workplace noise level and hearing loss, bivariate analysis

Association of workplace noise level each process section and hearing loss in either ear, left ear, and right ear are not significantly associated with hearing capacity (P-value > 0.05) as shown in Table 10 - Table 12.

Table 10 Association of workplace noise level and hearing loss in either ear, bivariate analysis

Area	Hearing capacity test – Either ear		P-value
	Normal n (%)	Hearing loss n (%)	
Polymerization process			0.621
Cutter section	12 (92.3)	1 (7.7)	
Filament yarn process			
Spinning section	18 (85.7)	3 (14.3)	
Drawing section	56 (94.9)	3 (5.1)	
Industrial yarn process			
Drawing section	13 (92.9)	1 (7.1)	
Staple fiber process			
Spinning section	11 (91.7)	1 (8.3)	
Total	110 (92.4)	9 (7.6)	

Remark : Statistically significant P-value < 0.05

Table 11 Association of workplace noise level and hearing loss in left ear, bivariate analysis

Area	Hearing capacity test – Left ear		P-value
	Normal n (%)	Hearing loss n (%)	
			0.705
Polymerization process			
Cutter section	12 (92.3)	1 (7.7)	
Filament yarn process			
Spinning section	19 (90.5)	2 (9.5)	
Drawing section	56 (94.9)	3 (5.1)	
Industrial yarn process			
Drawing section	14 (100.0)	0	
Staple fiber process			
Spinning section	11 (91.7)	1 (8.3)	
Total	112 (94.1)	7 (5.9)	

Remark : Statistically significant P-value < 0.05

Table 12 Association of workplace noise level and hearing loss in right ear, bivariate analysis

Area	Hearing capacity test – Right ear		P-value
	Normal n (%)	**Hearing loss n (%)**	
			0.863
Polymerization process			
Cutter section	12 (92.3)	1 (7.7)	
Filament yarn process			
Spinning section	19 (90.5)	2 (9.5)	
Drawing section	56 (94.9)	3 (5.1)	
Industrial yarn process			
Drawing section	13 (92.9)	1 (7.1)	
Staple fiber process			
Spinning section	11 (91.7)	1 (8.3)	
Total	111 (93.3)	8 (6.7)	

Remark : Statistically significant P-value < 0.05

4.7 Association of socio-demographic characteristics and hearing loss, bivariate analysis

Association of socio-demographic characteristics and hearing loss in either ear, left ear shows that working hour per day is significantly associated with hearing loss (P-value < 0.05) but age is significantly association with hearing loss only in the right ear (P-value < 0.05) as detail in Table 13 - Table 15.

Table 13 Association of socio-demographic characteristics and hearing loss in either ear, bivariate analysis

Characteristics	Hearing capacity – Either ear		P-value
	Normal n (%)	Hearing loss n (%)	
Sex			0.185
Male	47 (88.7)	6 (11.3)	
Female	63 (95.5)	3 (4.5)	
Age			0.034
20-29 years	8 (88.9)	1 (11.1)	
30-39 years	39 (100.0)	0	
40-49 years	50 (90.9)	5 (9.1)	
50-59 years	13 (81.2)	3 (18.8)	
Education			0.741
Primary school	4 (100.0)	0	
High school or vocational certificate	95 (92.2)	8 (7.8)	
Diploma or high vocational certificate	5 (83.3)	1 (16.7)	
Bachelor's degree or higher	6 (100.0)	0	

Income			1.000
Less than 10,000 Baht per month	1 (100.0)	0	
10,000 Baht per month or more	109 (92.4)	9 (7.6)	
Working duration			0.588
1-5 years	17 (94.4)	1 (5.6)	
6-10 years	14 (100.0)	0	
11-20 years	35 (94.6)	2 (5.4)	
20 years up	44 (88.0)	6 (12.0)	
Working hour per day			0.037 *
6-7 hours	56 (87.5)	8 (12.5)	
8 hours up	54 (98.2)	1 (1.8)	
Working history			0.559
Yes	9 (90.0)	1 (10.0)	
No	101 (92.7)	8 (7.3)	

Remark **:** Statistically significant P-value < 0.05

Table 14 Association of socio-demographic characteristics and hearing loss in left ear, bivariate analysis

Characteristics	Hearing capacity – Left ear		P-value
	Normal n (%)	Hearing loss n (%)	
Sex			0.240
Male	48 (90.6)	5 (9.4)	
Female	64 (97.0)	2 (3.0)	
Age			0.093
20-29 years	8 (88.9)	1 (11.1)	
30-39 years	39 (100.0)	0	
40-49 years	51 (92.7)	4 (7.3)	
50-59 years	14 (87.5)	2 (12.5)	
Education			0.646
Primary school	4 (100.0)	0	
High school or vocational certificate	97 (94.2)	6 (5.8)	
Diploma or high vocational certificate	5 (83.3)	1 (16.7)	
Bachelor's degree or higher	6 (100.0)	0	
Income			1.000
Less than 10,000 Baht per month	1 (100.0)	0	
10,000 Baht per month or more	111 (94.1)	7 (5.9)	
Working duration			0.507
1-5 years	17 (94.4)	1 (5.6)	
6-10 years	14 (100.0)	0	
11-20 years	36 (97.3)	1 (2.7)	
20 years up	45 (90.0)	5 (10.0)	

Working hour per day			0.015 *
6-7 hours	57 (89.1)	7 (10.9)	
8 hours up	55 (100.0)	0	
Working history			0.468
Yes	9 (90.0)	1 (10.0)	
No	103 (94.5)	6 (5.5)	

Remark **:** Statistically significant P-value < 0.05

Table 15 Association of socio-demographic characteristics and hearing loss in right ear, bivariate analysis

Characteristics	Hearing capacity – Right ear		P-value
	Normal n (%)	Hearing loss n (%)	
Sex			0.137
Male	47 (88.7)	6 (11.3)	
Female	64 (97.0)	2 (3.0)	
Age			0.047 *
20-29 years	9 (100.0)	0	
30-39 years	39 (100.0)	0	
40-49 years	50 (90.9)	5 (9.1)	
50-59 years	13.3 (81.3)	3 (18.7)	
Education			0.697
Primary school	4 (100.0)	0	
High school or vocational certificate	96 (93.2)	7 (6.8)	
Diploma or high vocational certificate	5 (83.3)	1 (16.7)	
Bachelor's degree or higher	6 (100.0)	0	
Income			1.000
Less than 10,000 Baht per month	1 (100.0)	0	
10,000 Baht per month or more	110 (93.2)	8 (6.8)	
Working duration			0.323
1-5 years	18 (100.0)	0	
6-10 years	14 (100.0)	0	
11-20 years	35 (94.6)	2 (5.4)	
20 years up	44 (88.0)	6 (12.0)	

Working hour per day			0.067
6-7 hours	57 (89.1)	7 (10.9)	
8 hours up	54 (98.2)	1 (1.8)	
Working history			0.516
Yes	102 (93.6)	7 (6.4)	
No	9 (90.0)	1 (10.0)	

Remark : Statistically significant P-value < 0.05

4.8 Association of personal behavior and hearing loss, bivariate analysis

Association of personal behavior and hearing loss in either ear, left ear and right ear shows that frequency to uses hearing protective devices (HPDs) is significantly associated with hearing loss (P-value < 0.05) as shown in Table 16 - Table 18.

Table 16 Association of personal behavior and hearing loss in either ear, bivariate analysis

Characteristics	Hearing capacity – Either ear		P-value
	Normal hearing n (%)	Hearing loss n (%)	
Listen to a song by headphones			0.740
Every day	4 (100.0)	0	
Every week	6 (100.0)	0	
Less than 1 time per week	21 (87.5)	3 (12.5)	
Never	79 (92.9)	6 (7.1)	

Go to discotheque, pub, karaoke			0.712
Every week	1 (100.0)	0	
Every month	1 (100.0)	0	
Less than 1 time per month	19 (90.5)	2 (9.5)	
Never	89 (92.7)	7 (7.3)	
Hearing protective device uses			-
Yes	112 (94.1)	7 (5.9)	
No	0	0	
Type of hearing protective devices			0.601
Ear plug : foam	95 (91.3)	9 (8.7)	
Ear plug : silicone	15 (100.0)	0	
Ear muff	0	0	
Frequency to use hearing protective device (HPDs)			0.001 *
Use every times during work	87 (97.8)	2 (2.2)	
Use sometimes during work	23 (76.7)	7 (23.3)	
Never use	0	0	

Remark **:** Statistically significant P-value < 0.05

Table 17 Association of personal behavior and hearing loss in left ear, bivariate analysis

Characteristics	Hearing capacity – Left ear		P-value
	Normal hearing n (%)	Hearing loss n (%)	
Listen to a song by headphones			0.479
Every day	4 (100.0)	0	
Every week	6 (100.0)	0	
Less than 1 time per week	21 (87.5)	3 (12.5)	
Never	81 (95.3)	4 (4.7)	
Go to discotheque, pub, karaoke			0.652
Every week	1 (100.0)	0	
Every month	1 (100.0)	0	
Less than 1 time per month	19 (90.5)	2 (9.5)	
Never	91 (94.8)	5 (5.2)	
Hearing protective devices uses			-
Yes	112 (94.1)	7 (5.9)	
No	0	0	
Type of hearing protective device			0.594
Ear plug : foam	97 (93.3)	7 (6.7)	
Ear plug : silicone	15 (100.0)	0	
Ear muff	0	0	
Frequency to use hearing protective device (HPDs)			0.001 *
Use every times during work	88 (98.9)	1 (1.1)	
Use sometimes during work	24 (80.0)	6 (20.0)	
Never use	0	0	

Remark : Statistically significant P-value < 0.05

Table 18 Association of personal behavior and hearing loss in right ear, bivariate analysis

Characteristics	Hearing capacity – Right ear		P-value
	Normal hearing n (%)	Hearing loss n (%)	
Listen to a song by headphones			1.000
Every day	4 (100.0)	0	
Every week	6 (100.0)	0	
Less than 1 time per week	22 (91.7)	2	
Never	79 (92.9)	6	
Go to discotheque, pub, karaoke			0.681
Every week	1 (100.0)	0	
Every month	1 (100.0)	0	
Less than 1 time per month	19 (90.5)	2 (9.5)	
Never	90 (93.8)	6 (6.2)	
Hearing protective device uses			-
Yes	111 (93.3)	8 (6.7)	
No	0	0	
Type of hearing protective device			0.594
Ear plug : foam	96 (92.3)	8 (7.7)	
Ear plug : silicone	15 (100.0)	0	
Ear muff	0	0	
Frequency to use hearing protective devices (HPDs)			< 0.001 *
Use every times during work	88 (98.9)	1 (1.1)	
Use sometimes during work	23 (76.7)	7 (23.3)	
Never use	0	0	

Remark : Statistically significant P-value < 0.05

4.9 Multiple logistic regression analysis

The multiple logistic regression analysis presents the association between each independent variable (workplace noise level, socio-demographic characteristics and personal behavior) and dependent variable (hearing loss) with p-values, odds ratios, and confidence interval. These following tables are the final multivariable logistic regression which included the independent variables that have P-value < 0.20 from first step of multiple logistic regression, that are not shown in here and some interesting independent variables.

In Table 19, there is the result of significantly association between hearing loss either ear from noise average level and use HPDs sometimes vs. always (OR = 8.709, 95% CI : 1.528-49.631, P-value = 0.015). In Table 20, there is found the significantly association between hearing loss either ear from noise max level and use HPDs sometimes vs. always (OR = 9.217, 95% CI : 1.608-52.834, P-value = 0.013).

Table 19 Multiple logistic regression relating to hearing loss in either ear and noise average level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise average 8 hr. 2014 [dB(A)]	1.013	0.907-1.131	0.822
Female vs. male	0.244	0.039-1.533	0.132
Age (years)	1.942	0.504-7.488	0.335
Working duration (years)	1.044	0.357-3.048	0.937
Working hour (hours per day)	0.219	0.024-2.012	0.179
Use HPDs sometimes vs. always	8.709	1.528-49.631	0.015 *

Remark **:** Statistically significant P-value < 0.05

Table 20 Multiple logistic regression relating to hearing loss in either ear and noise max level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise max 2014 [dB(A)]	1.028	0.877-1.205	0.736
Female vs. male	0.254	0.045-1.430	0.120
Age (years)	2.017	0.510-7.980	0.318
Working duration (years)	1.015	0.339-3.040	0.979
Working hour (hours per day)	0.226	0.024-2.110	0.192
Use HPDs sometimes vs. always	9.217	1.608-52.834	0.013 *

Remark **:** Statistically significant P-value < 0.05

In Table 21, there is the result of significantly association between hearing loss in left ear from noise average level and use HPDs sometimes vs. always (OR = 16.454, 95% CI : 1.610-168.201, P-value = 0.018). In Table 22, Also found the significantly association between hearing loss in left ear from noise max level and use HPDs sometimes vs. always (OR = 16.885, 95% CI : 1.675-170.173, P-value = 0.016).

Table 21 Multiple logistic regression relating to hearing loss in left ear and noise average level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise average 8 hr. 2014 [dB(A)]	1.011	0.890-1.148	0.868
Female vs. male	0.186	0.022-1.599	0.125
Age (years)	1.194	0.275-5.177	0.813
Working duration (years)	1.262	0.355-4.482	0.719
Working hour (hours per day)	0.000	0.000	0.997
Use HPDs sometimes vs. always	16.454	1.610-168.201	0.018 *

Remark **:** Statistically significant P-value < 0.05

Table 22 Multiple logistic regression relating to hearing loss in left ear and noise max level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise max 2014 [dB(A)]	0.997	0.837-1.187	0.970
Female vs. male	0.198	0.025-1.545	0.122
Age (years)	1.167	0.254-5.364	0.843
Working duration (years)	1.291	0.348-4.788	0.702
Working hour (hours per day)	0.000	0.000	0.997
Use HPDs sometimes vs. always	16.885	1.675-170.173	0.016 *

Remark **:** Statistically significant P-value < 0.05

In Table 23, there are the result of significantly association between hearing loss in right ear from noise average level and female vs. male (OR = 0.059, 95% CI : 0.005-0.685, P-value = 0.024), and use HPDs sometimes vs. always (OR = 19.668, 95% CI : 1.793-215.792, P-value = 0.015).

In Table 24, also found the significantly association between hearing loss in right ear from noise max level and female vs. male (OR = 0.058, 95% CI : 0.006-0.615, P-value = 0.018), and use HPDs sometimes vs. always (OR = 22.281, 95% CI : 1.935-256.603, P-value = 0.013).

Table 23 Multiple logistic regression relating to hearing loss in right ear and noise average level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise average 8 hr. 2014 [dB(A)]	1.014	0.880-1.169	0.843
Female vs. male	0.059	0.005-0.685	0.024 *
Age (years)	4.839	0.682-34.326	0.115
Working duration (years)	1.770	0.415-7.541	0.440
Working hour (hours per day)	0.243	0.020-2.903	0.264
Use HPDs sometimes vs. always	19.668	1.793-215.792	0.015 *

Remark : Statistically significant P-value < 0.05

Table 24 Multiple logistic regression relating to hearing loss in right ear and noise max level

Variables	Hearing loss		
	Adjusted OR	**95% CI**	**P-value**
Noise max 2014 [dB(A)]	1.058	0.849-1.317	0.617
Female vs. male	0.058	0.006-0.615	0.018 *
Age (years)	5.203	0.707-38.272	0.105
Working duration (years)	1.714	0.396-7.413	0.471
Working hour (hours per day)	0.268	0.022-3.216	0.299
Use HPDs sometimes vs. always	22.281	1.935-256.603	0.013 *

Remark : Statistically significant P-value < 0.05

There were 3 major findings in the current study, as follows; 1.There was no significantly association of any hearing loss with either of the measured noise levels ($p > 0.617$); 2. In all analyses, risk of hearing loss was significantly higher in subjects who did not always use ear plugs than in those who always used them; 3.Independent variables were more strongly associated with hearing loss in the right ear than with hearing loss in the left ear or hearing loss in either ear.

CHAPTER V
CONCLUSION, DISCUSSION, AND RECOMMENDATION

This chapter consists of the conclusion, discussion (including interpretation of findings), limitation, and recommendations. This study is a cross-sectional study that collected the data of workplace noise level, hearing capacity, and personal questionnaire in a Polyester Fiber factory. The aims of this study are characterize the prevalence of occupational hearing loss, identify the risk factors of occupational hearing loss, and identify the association between risk factors and occupational hearing loss among polyester fiber workers. This study data was analyzed by bivariate analysis and multiple logistic regression analysis.

5.1 Conclusion

5.1.1 Descriptive Information

Workplace noise level was monitored by third party (registered company to Department of Industrial Work, Ministry of Industry) 1 time per year as Ministry of Labor's regulation, Thailand B.E. 2549 (2006) at high noise level area total 5 areas located in cutter, spinning, and drawing process. The results in 2014 present that average 8 hours of noise level all areas was between 67.8-92.0 dB(A). The maximum noise level was between 86.0-105.8 dB(A).

The interview questionnaire in this study, follows the Guidelines of Hearing Loss Monitoring from Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, B.E. 2547 (2004) which consist of socio-demographic characteristics and working history part, personal health and risk behavior part, and hearing protective device uses part. Most of questions are set to be answered by yes or no, or categorical choices.

After screening the participants by interview questionnaire, worker 119 persons from 130 persons were included in the study. There are male 53 persons (44.5%) and female 66 persons (55.5%). Most age of workers are in a range 40-49 years (55 persons, 46.2%). Mean of age is 40.6, median = 41.0, minimum age is 24, and maximum age is 55 years old. Most workers graduated from high school or vocational certificate 103 persons (86.6%). Almost workers 118 persons (99.2%) get an income more than 10,000 Baht per month. Most workers 50 persons (42.0%) have working experiences more than 20 years. Mean of working experience is 17.8, median of working experience = 18.0, minimum working experience = 1, and maximum working experience = 37 years. Most workers 64 persons (53.8%) usually work around 6-7 hours per day, and workers 109 persons (91.6%) have no working experience in the past.

In the personal behavior part, the result from questionnaires show that most of workers 85 persons (71.4%) have never listened to a song by headphones and workers 96 persons (80.7%) have never go to discotheque, pub, or karaoke. All workers 119 persons (100.0%) used hearing protective devices (HPDs) and most of HPDs are ear plug-foam. Most workers 89 persons (74.8%) use HPDs every times during work.

The result of auditory symptoms in preceding 3 months at either ear, left ear, and right ear shows the prevalence of full ear 18.5% (22 from 119 persons), and prevalence of tinnitus 5.9% (7 from 119 persons).

An audiometry test was done by licensed audiologist from hospital in September 2014 showed that after test by pure-tone air conduction at frequencies 500, 1000, 2000, 3000, 4000, and 6000 Hz respectively. Then interpretation of the data was conducted by using the criteria of Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health B.E. 2547 (2004). If an average hearing threshold level in either ears that equals or exceeds 25 decibel at 500, 1000, 2000, 3000 Hz and equals or exceeds 45 decibel at 4000, 6000 Hz, the audiometry test was interpreted as hearing loss. Thus the result show that prevalence of hearing loss of workers at either ear, left ear, and right ear are 7.6% (9 from 119 persons).

.5.12 Analytical Information

The association between each independent variable (workplace noise level, socio-demographic characteristics and personal behavior) and dependent variable (occupational hearing loss) was performed by bivariate analysis (fisher's exact test). The association between socio-demographic characteristics and hearing loss at either ear, left ear, right ear show that working hour per day is significantly associated with hearing loss (P-value < 0.05). For the result of association between personal behavior and hearing loss at either ear, left ear, right ear show that frequency to uses HPDs is significantly associated with hearing loss (P-value < 0.05).

In multiple logistic regression analysis, factors that have P-value < 0.20 in previous bivariate analysis (fisher's exact test) were selected to perform in step 1 of multivariate analysis to find out those variable which have P-value < 0.20 again. Then cut off those with P-value > 0.20 and run step 2 of multivariate analysis with those variables that P-value < 0.20 including some interesting independent variables. In final multivariable logistic regressions, show the result of adjusted Odd ratio, P-value < 0.05 (statistical significant) and 95% confidence interval.

The results show that there is significantly association between hearing loss either ear and workers who use HPDs sometimes, more than the workers who use HPDs every time during work (P-value < 0.05).

In the left ear, there is the result of significantly association between hearing loss in left ear and workers who use HPDs sometimes, more than the workers who use HPDs every time during work (P-value < 0.05).

In the right ear, there are the result of significantly association between hearing loss in right ear and female, more than male (P-value < 0.05). Also found the significantly association between hearing loss in right ear and workers who use HPDs

sometimes, more than the workers who use HPDs every time during work (P-value < 0.05).

In this study, after analyzed the association between independent variables with dependent variables, there were 3 major findings as follows: 1. There was no significantly association of any hearing loss with either of the measured noise levels ($p > 0.617$); 2. In all analyses, risk of hearing loss was significantly higher in subjects who did not always use ear plugs than in those who always used them; 3. Independent variables were more strongly associated with hearing loss in the right ear than with hearing loss in the left ear or hearing loss in either ear.

5.2 Discussion

In the present study there was no association of measured noise level with hearing loss. The prevalence of hearing loss was low, only 7.6%. This may have limited the statistical power to detect an association of hearing loss with noise level (as well as with other independent variables). Also, measured noise levels were not especially high; perhaps they were too low to exhibit associations with hearing loss as measured in this study. Furthermore, the noise measurements used in analysis were area measurements made over only one day; they may not have been representative of subjects' personal noise exposures.

Workplace noise level in this study was conducted in year 2014. Although there was no significantly association of any hearing loss with either of the measured noise levels ($p > 0.05$). The results of noise level average 8 hours in some areas were higher than the standard of Ministry of Industry B.E. 2546 (2003) and Ministry of Labor B.E. 2549 (2006) which limit noise average 8 hours shall not exceed 90 dB(A) and also higher than the standard of Ministry of Labor B.E. 2553 (2010) which specified to conduct the hearing conservation program if noise level in the workplace is higher than 85 dB(A). However these high noise levels could affect to hearing of workers to be more hearing loss. Thus the factory should consider for making decision for improvement noise reduction such as engineering control, or hearing conservation program. As the study in 1997 from Department of Occupational Health

about hearing loss and accident of workers in textile factories total 853 persons. The study found that average noise level 8 hours were more than 90 dB(A), prevalence of hearing loss was 57.2%, and noise level and working duration was significantly associate with hearing loss [12].

The result of auditory symptoms in preceding 3 months at either ear or both ears show that workers 22 persons (18.5%) have fullness ear and workers 7 persons (5.9%) have tinnitus. Although fullness ear and tinnitus are the clinical description of hearing loss, but when compare the hearing test of workers with auditory symptoms-it was not comply. So this study decided to use only hearing test to find the association with independent variables.

Regarding the different of criteria for hearing loss consideration, each study has found the prevalence of hearing loss differently. In Thailand, prevalence of hearing loss was found in the workplace which have high level noise from 4.6%-83% [12]. In this study, the prevalence of hearing loss was found 7.6% (9 from 119 persons) by using the criteria to identify hearing loss as the guideline of Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, Thailand – after hearing test, if an average hearing threshold level in either ears that equals or exceeds 25 decibel at 500, 1000, 2000, 3000 Hz and equals or exceeds 45 decibel at 4000, 6000 Hz, it means hearing loss. However when observe at hearing test of all studied workers at frequencies 500, 1000, 2000, 3000, 4000, and 6000 Hz, much hearing threshold results were more than 25 decibel at some frequencies which Bureau of Epidemiology, Department of Disease Control, Ministry of Public Health, identify as a surveillance level. That means although the studied workers did not have hearing loss but they have risk and might have the hearing loss in the future. This variable, expressing potential increased risk for future hearing loss was not analyzed in the present study.

Use of ear plugs less than all the time was consistently associated with increased risk of hearing loss. Further research is required to ascertain the reasons for this observation.

When observed at the association between hearing loss either ear, left ear, and right ear with sex. The study found that hearing loss is significantly associate with female in the right ear (P-value>0.05) more than male. Normally hearing loss occurs in both ears (bilateral) more than one ear (unilateral). However it depends on sensitivity of each ear and each person (genetic factor). As the study in 1986 of boat driver total 92 persons, the results presented that the driver exposed to hearing loss 76 persons (83%). It also found that all drivers suffered from hearing loss in right ear more than left ear [37]. Another studied in 1991 in a pellets factory in Chonburi province, the study found that prevalence of hearing loss of workers was 52.30%. Most workers exposed to hearing loss both ears and left ear affected from hearing loss more than right ear [38].

Although most workers used hearing protective devices (HPDs) every times during work (74.8%) but after analyzed the association between hearing loss either ear, left ear, and right ear with frequency to uses hearing protective devices (HPDs),the results show that uses of HPDs sometimes is significantly associate with hearing loss (P-value<0.05) more than uses of HPDs every times. However when observe the actual operation of the workers in the workplace, the workers sometimes did not wear HPDs during work. That might causes from the HPDs is not comfortable for using, HPDs is not enough, or the workers did not have the enough knowledge for using HPDs.

5.3 Limitation

Regarding to workplace noise monitoring in the factory was conducted only 1 time per year (during 8 working hours) to follow the laws of Ministry of Industry, Thailand B.E. 2546 (2003) and Ministry of Labor, Thailand B.E. 2549 (2006). In the year 2014 during noise level monitoring, there might be some machine stop because of noise level in some areas below 85 dB(A) and affected to could not found the association between workplace noise level with hearing loss of workers in this study. However during noise level monitoring, there was no any record of exactly operating machine.

The audiometry test of workers in this study was conducted 1 time per year to follow the law of Ministry of Labor, Thailand B.E. 2553 (2010). Although the factory conducted the audiometry test since year 2011 but quality control was adequate only in year 2014. So the results of audiometry test between year 2011- 2013 could not use to find the association between independent variables with hearing loss and compare with the result of year 2014.

According to this study is cross sectional study which was conducted in a time period, so the workers who transferred to other sections or retired were excluded in the study. These workers might have risk or tend to have hearing loss in the future. The monitoring of hearing loss situation in these workers should be continued.

According to this study was performed within specific industry company as polyester fiber factory, there is no the past research which study in the same type of factory. So this study could be the new survey and the result from this study could not compare with other same type of factories.

The result of this study does not represent to hearing loss of workers in a Polyester Fiber factory in a whole country. It is assumingly represents to situation of hearing loss in this Polyester Fiber factory only.

5.4 Recommendation

According to the study finds prevalence and risk factors of hearing loss which are identified in a polyester fiber factory, the result from the study will be the new survey in this type of factory because researches in the past never. Additionally working environment in a polyester fiber factory is different from others because of specific machinery at the workplace, so this study will be useful for further researches to study.

Although this study only found the prevalence of hearing loss 7.6%, all the workers especially who work in high noise level area more than 85 dB(A) still need to

conduct audiometry test at least 1 time per year and compare the result with baseline audiogram.

In the researcher's opinion, the present findings do not yet support specific recommendations for factory owners or policy makers. However to protect the workers from having hearing loss in the future, improved hearing conservation programs, and safety and health education for industrial workers, would be desirable as detail;

1. The owner factory shall provide a continuing and effective hearing conservation program whenever employee noise exposures equal or exceed an 8-hour time-weighted average sound level (TWA) of 85 decibels measured on the A scale. This hearing conservation program must incorporate five factors; 1. Periodic noise exposure monitoring including repeat monitoring whenever changes in production, process, or control increase noise exposure; 2. Engineering and administrative controls; 3. Personal hearing protection; 4. Audiometric evaluations and follow up activities; and 5. Education and training management of employee.

2. The training program for workers to understand the reasons for hearing conservation is important. The owner factory shall train workers who exposed to high noise level 85 dB(A) and above at least annually in effects of noise such as purposes, advantages, and disadvantages of hearing protectors; the selection, fit, and care of hearing protectors.

3. The owner factory shall monitoring and enforce the workers who work in high noise level workplace, to wear hearing protective devices (HPDs) during routine working hour including overtime period.

This study may give an idea for further researches to gain more knowledge of public health. For health personnel, this finding will be useful to give advice to workers in order to encourage the workers to find the way to protect themselves from occupational hearing loss.

For further researchers, the researchers can find the other risks of occupational hearing loss such as knowledge, attitude, and behavior of hearing personal devices (HPDs) of workers.

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APPENDIX-A

Employee ID ……..……

Questionnaire for the employee who attend the audiometry test

Topic : Hearing loss in relation to occupational noise levels among worker in a polyester fiber factory in Thailand

Direction : The questionnaire consist of 3 parts ;
Part 1 : Personal information and working history
Part 2 : Personal health and behavior
Part 3 : Personal protective equipment uses

Please marking (✓) in the box or fill the your information that correspond background is you are mostly

Part 1 : Personal information and working history

1.1 Sex ☐ Male ☐ Female

1.2 Age _____Year _____Month

1.3 Level of education

☐ Primary School ☐ High School / Vocational Certificate

☐ Diploma / High Vocational Certificate ☐ Bachelor's degree or higher

1.4 Income (with OT)

☐ Less than 10,000 Baht ☐ 10,000 Baht or more

1.5 Now work in Department_____Section_____

Working experience in this department

☐ 1-5 Years ☐ 6-10 Years

☐ 11-20 Years ☐ More than 20 years old

Working time per day

☐ 2-3 Hours ☐ 4-5 Hours

☐ 6-7 Hours ☐ More than 8 hours

1.6 Before working in this department, Have you ever work in high noise level area?

☐ Yes (detail) ☐ No

1) Department/Company _____

Working experience

☐ 1-5 Years ☐ 6-10 Years

☐ 11-20 Years ☐ More than 20 years old

2) Department/Company _____

Working experience

☐ 1-5 Years ☐ 6-10 Years

☐ 11-20 Years ☐ More than 20 years old

Part 2 : Personal health and behavior

2.1 Has a doctor ever said that you had any of the following illnesses?

1) Otitis media ☐ Yes ☐ No

2) Head injury or unconsciousness such as fall head struck against something, head injury, car accident ☐ Yes ☐ No

3) Sudden hearing loss such as bomb, gun, or firecracker ☐ Yes ☐ No

4) Often sore throat and flu ☐ Yes ☐ No

5) Sinusitis ☐ Yes ☐ No

6) Subperiosteal abscess ☐ Yes ☐ No

7) Taking or injection medicine ☐ Yes ☐ No

2.2 In your family or relatives, are there any deaf, hard of hearing,?

☐ Yes (detail)_____ ☐ No

2.3 In the past 3 months, have you ever had one or more of the following symptoms?

1) Fullness in ears	☐ Yes	☐ No
2) Noise in ears	☐ Yes	☐ No
3) Dizziness	☐ Yes	☐ No

2.4 Have you ever listen to the song by headphones?

☐ Yes (detail) ☐ No

- ☐ Every day
- ☐ Every week
- ☐ Less than 1 time per week

2.5 Have you ever go to discotheque, pub, or karaoke?

☐ Yes (detail) ☐ No

- ☐ Every week
- ☐ Every month
- ☐ Less than 1 time per month

Part 3 : Hearing protective device

3.1 Do you use hearing protective device (HPDs) while working?

☐ Yes ☐ No

3.2 What type of hearing protective device (HPDs) have you used in the past year?

(You may check more than one.)

☐ Ear plug Type ☐ Silicone ☐ Foam

☐ Ear muff

3.3 How often do you use hearing protective device (HPDs) while working?

☐ Use every times during work

☐ Use sometimes during work

☐ Never

APPENDIX-B

รหัสพนักงาน .....

แบบสัมภาษณ์ผู้รับการตรวจสมรรถภาพการได้ยิน

เรื่อง การสำรวจการได้ยินที่เกี่ยวข้องกับระดับเสียงจากการทำงานของคนงานในโรงงานผลิตเส้นใยโพลีเอสเตอร์ในประเทศไทย

คำชี้แจง : แบบสัมภาษณ์ประกอบด้วย 3 ส่วนคือ

ส่วนที่ 1 : ข้อมูลส่วนบุคคลและประวัติการทำงาน

ส่วนที่ 2 : ข้อมูลสุขภาพและการปฏิบัติตน

ส่วนที่ 3 : การใช้อุปกรณ์ป้องกันเสียงดัง

กรุณาทำเครื่องหมายถูก (✓) หน้าข้อความที่ต้องการตอบ หรือเติมข้อความลงในช่องว่างที่ตรงตาม ความเป็นจริงเกี่ยวกับตัวท่านมากที่สุด

ส่วนที่ 1 : ข้อมูลส่วนบุคคลและประวัติการทำงาน

1.1 เพศ ☐ ชาย ☐ หญิง

1.2 อายุ _____ปี _____เดือน

1.3 ระดับการศึกษา

☐ ประถมศึกษา ☐ มัธยมศึกษา / ปวช

☐ อนุปริญญา / ปวส ☐ ปริญญาตรี หรือสูงกว่า

1.4 รายได้ต่อเดือนรวมค่าล่วงเวลา

☐ น้อยกว่า 10,000 บาท ☐ 10,000 บาทขึ้นไป

1.5 ปัจจุบันทำงานในแผนก_____หน่วยงาน_____

ระยะเวลาการทำงาน

☐ 1-5 ปี ☐ 6-10 ปี

☐ 11-20 ปี ☐ มากกว่า 20 ปี

ชั่วโมงการทำงานที่ท่านสัมผัสเสียงดังในแต่ละวัน

☐ 2-3 ชั่วโมง ☐ 4-5 ชั่วโมง

☐ 6-7 ชั่วโมง ☐ มากกว่า 8 ชั่วโมง

1.6 ประวัติการทำงาน เคยทำงานในพื้นที่ที่มีเสียงดังมาก่อนทำงานในแผนกนี้หรือไม่

☐ เคย ระบุรายละเอียด ☐ ไม่เคย

1) แผนก/บริษัท _____

ระยะเวลาการทำงาน

☐ 1-5 ปี ☐ 6-10 ปี

☐ 11-20 ปี ☐ มากกว่า 20 ปี

2) แผนก/บริษัท _____

ระยะเวลาการทำงาน

☐ 1-5 ปี ☐ 6-10 ปี

☐ 11-20 ปี ☐ มากกว่า 20 ปี

ส่วนที่ 2 : ข้อมูลสุขภาพและการปฏิบัติตน

2.1 ท่านมีความผิดปกติของหูหรือเคยได้รับการวินิจฉัยจากแพทย์ว่ามีอาการเหล่านี้บ้างหรือไม่

1) หูน้ำหนวก ☐ ใช่ ☐ ไม่ใช่

2) อุบัติเหตุที่ศีรษะ/หู อย่างแรง จนหูอื้อหรือแก้วหูทะลุ เช่น ล้มหัวฟาด, ถูกตีที่ศีรษะ, อุบัติเหตุรถยนต์ ☐ ใช่ ☐ ไม่ใช่

3) ปวดหูหรือหูอื้อ หลังได้ยินเสียงดังมากๆ เช่น เสียงระเบิด เสียงปืน หรือเสียงปะทัด ☐ ใช่ ☐ ไม่ใช่

4) เป็นหวัดเจ็บคอบ่อยๆ ☐ ใช่ ☐ ไม่ใช่

5) ไซนัสอักเสบ ☐ ใช่ ☐ ไม่ใช่

6) เป็นฝีหลังกกหู ☐ ใช่ ☐ ไม่ใช่

7) กินยาหรือฉีดยาจนหูตึง ☐ ใช่ ☐ ไม่ใช่

2.2 ในครอบครัวท่านมีญาติพี่น้องที่หูหนวก หรือหูตึง หรือไม่

☐ มี ระบุ_____ ☐ ไม่มี

2.3 ในช่วง 3 เดือนที่ผ่านมา ท่านมีความผิดปกติของหูหรือมีอาการเหล่านี้บ้างหรือไม่

1) มีอาการหูอื้อ หรือได้ยินแต่ไม่ค่อยชัดเจน ☐ ใช่ ☐ ไม่ใช่

2) มีเสียงดังรบกวนในหู ☐ ใช่ ☐ ไม่ใช่

3) เวียนศีรษะบ้านหมุน ☐ ใช่ ☐ ไม่ใช่

2.4 ท่านฟังเพลงเสียงดังหรือใช้หูฟัง (ซาวเบาท์) เป็นประจำหรือไม่

☐ ใช่ (ระบุ) ☐ ไม่ใช่

☐ ฟังทุกวัน

☐ ฟังทุกสัปดาห์

☐ น้อยกว่า 1 ครั้งต่อสัปดาห์

2.5 ท่านไปเที่ยวดิสโก้เทค, ผับ, คาราโอเกะ เป็นประจำหรือไม่

☐ ใช่ (ระบุ) ☐ ไม่ใช่

☐ ทุกสัปดาห์

☐ ทุกเดือน

☐ น้อยกว่า 1 ครั้งต่อเดือน

ส่วนที่ 3 : การใช้อุปกรณ์ป้องกันเสียงดัง

3.1 ท่านใช้อุปกรณ์ป้องกันเสียงดังหรือไม่

☐ ใช่ ☐ ไม่ใช่

3.2 ท่านใช้อุปกรณ์ป้องกันเสียงดังชนิดใด (ตอบได้มากกว่า 1 ข้อ)

☐ ปลั๊กอุดหู ชนิด ☐ ซิลิโคน ☐ โฟม

☐ ที่ครอบหู (Ear Muff)

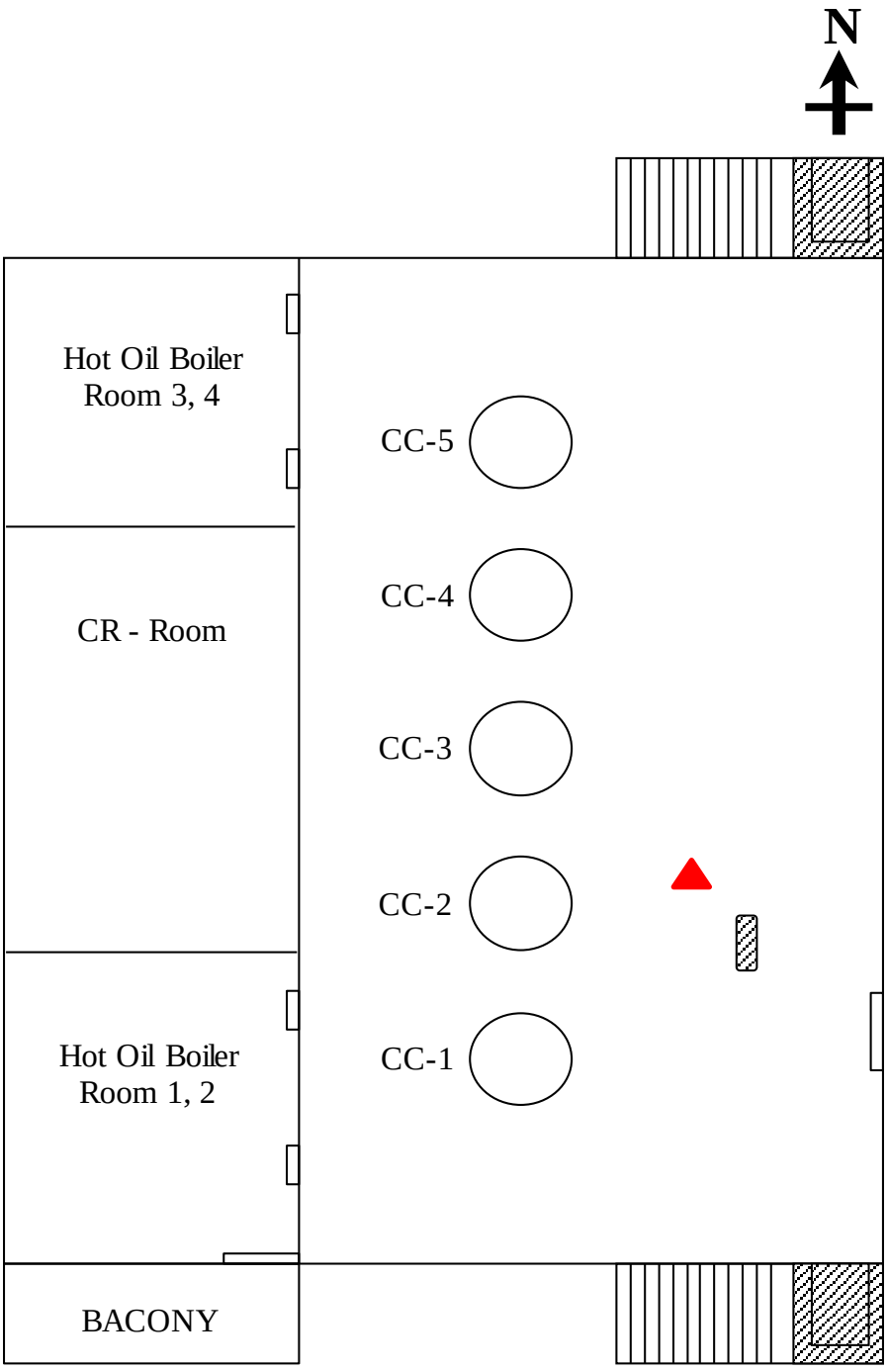
3.3 ท่านใช้อุปกรณ์ป้องกันเสียงดังขณะปฏิบัติงานอย่างไร

☐ สวมใส่อุปกรณ์ป้องกันเสียงดัง ทุกครั้ง ตลอดเวลาการปฏิบัติงาน

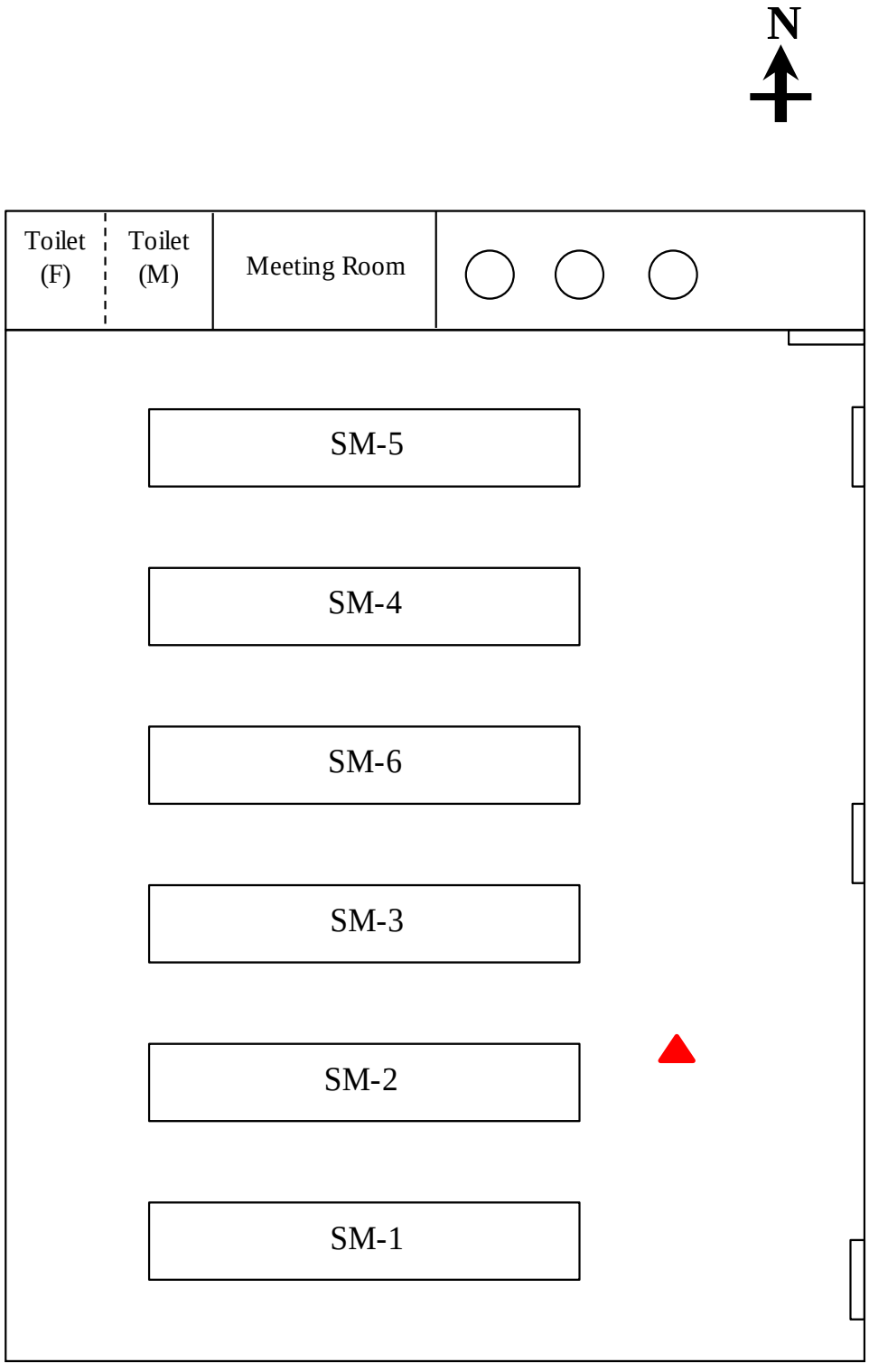
☐ สวมใส่อุปกรณ์ป้องกันเสียงดัง บางขณะ เวลาการปฏิบัติงาน

☐ ไม่ได้ สวมใส่อุปกรณ์ป้องกันเสียงดังเวลาปฏิบัติงาน

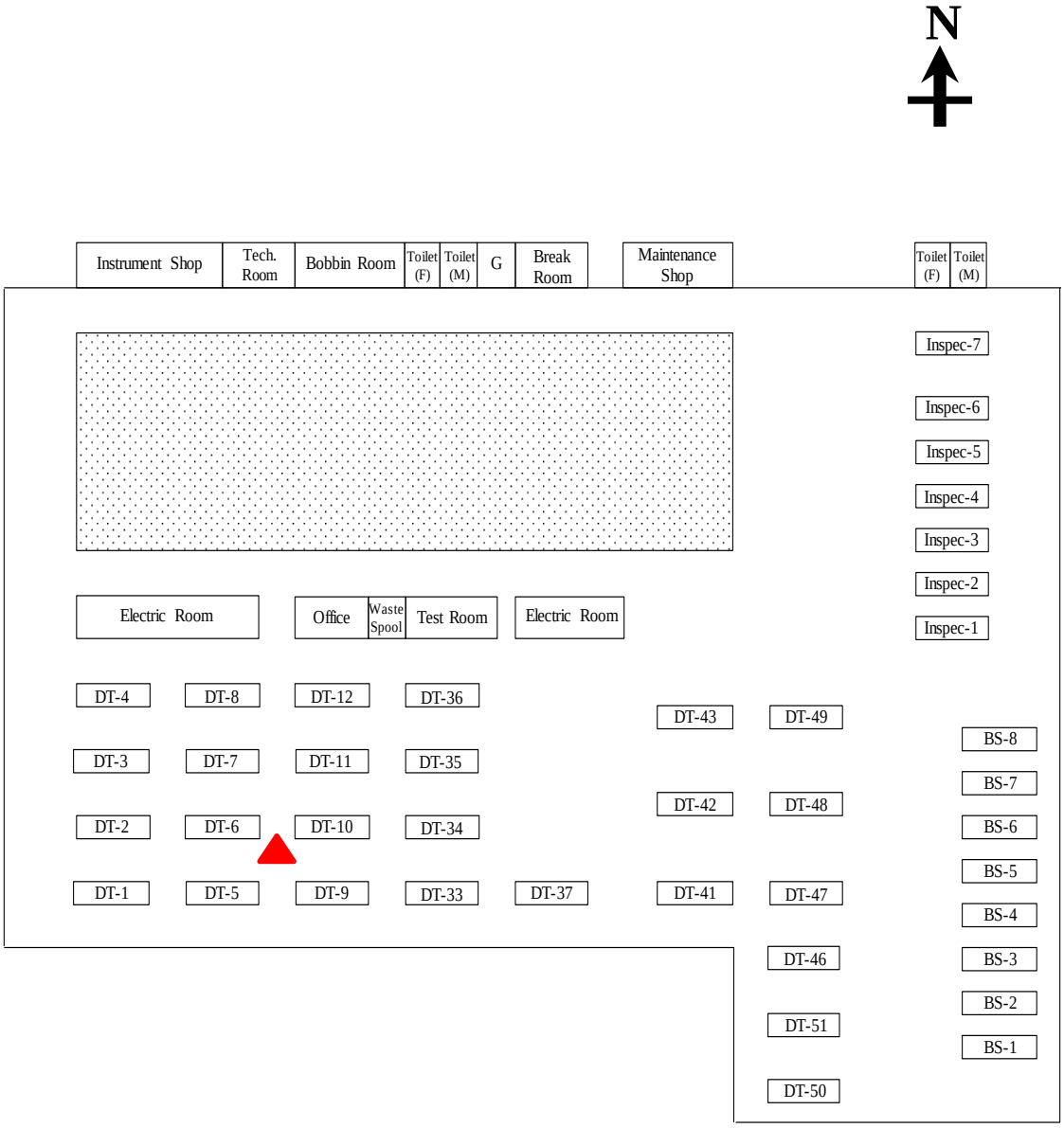
APPENDIX-C



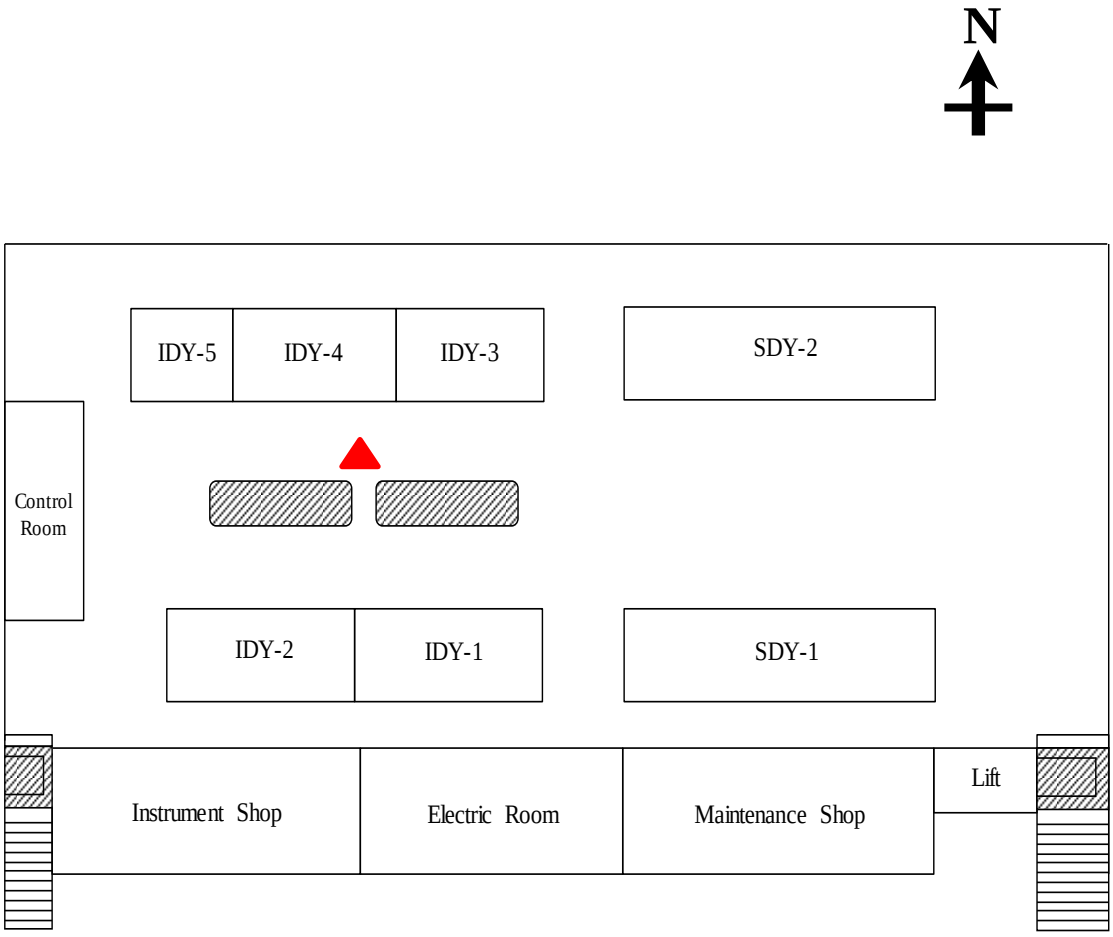
Layout of Noise Level Monitoring
Polymerization Process : Cutter Section



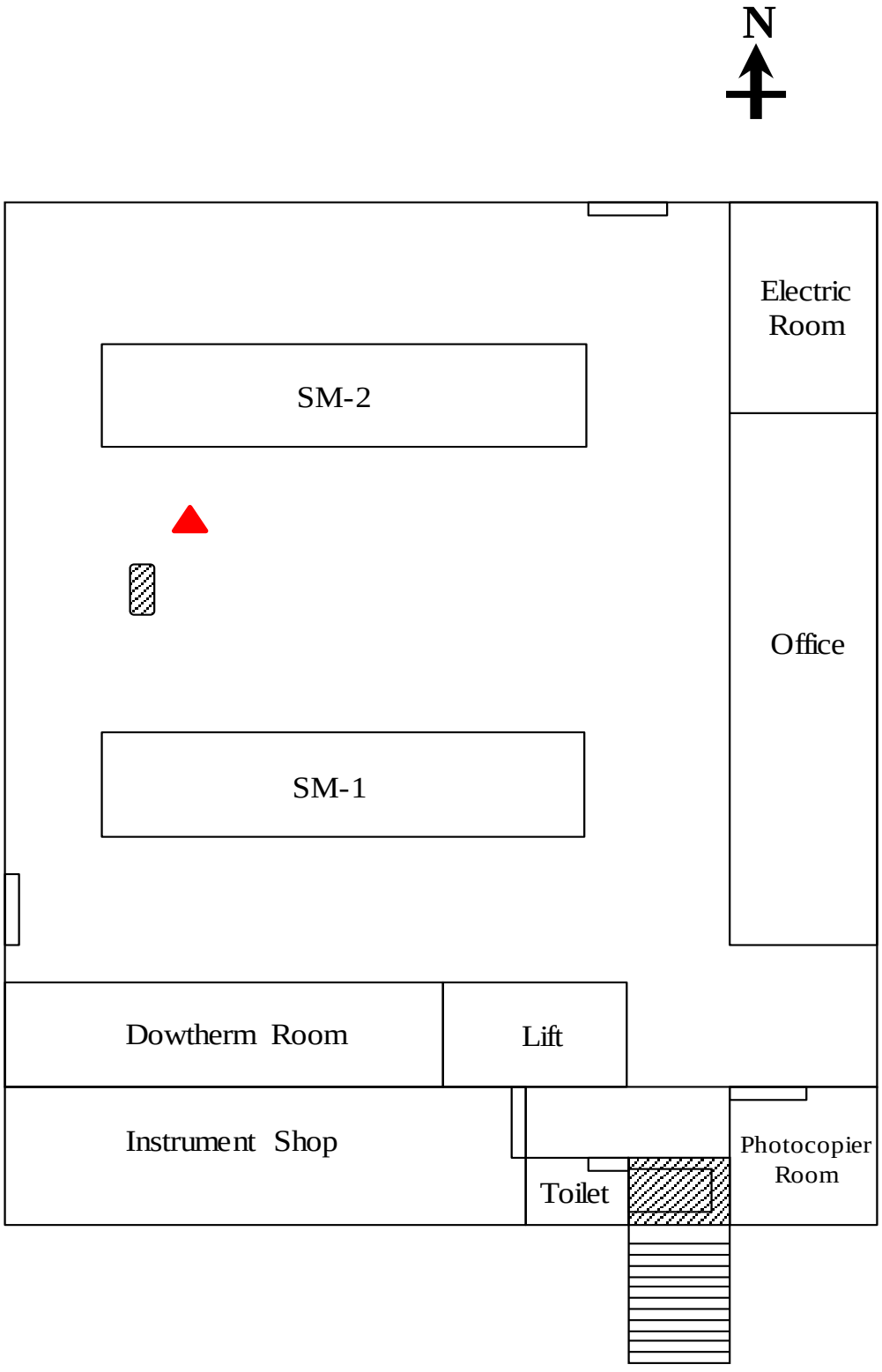
Layout of Noise Level Monitoring
Filament Yarn Process : Spinning Section



Layout of Noise Level Monitoring
Filament Yarn Process : Drawing Section



Layout of Noise Level Monitoring
Industrial Yarn Process : Drawing Section



Layout of Noise Level Monitoring
Staple Fiber Process : Spinning Section

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