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Hearing Capacity, Noise Level Exposure and Health Effects in Workers of Pulp and Paper Plant, Khon Kaen Province

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Abstract

Hearing loss is one of the diseases from working. This study examined the worker's hearing capacity, health effect, frequency and sound level in each department and the relationship between sound level and hearing capacity of the pulp and paper plant's employees. A sample was selected from 207 cases, 8 departments from January to March 2018. The apparatuses were sound level meter and questionnaires. The findings indicated samples were male workers, 98.70% ages between 30 and 39 that worked in production and 58.94% of workers have worked for 5-10 years. The hearings of samples 73.91% were normal. The highest frequency of irregular hearing (4000-6000 Hz.) estimated 59.26 during working showed that 57.49% of workers have headache (72.46%), stress (35.75%) and mishearing (32.85%). Sound level in the workplace approximated 75.5-89.2 dB(A), found at 1000-2000 Hz. that no exceed standards. Sound level and hearing capacity of workers considerably related in statistic (OR_{adj}= 4.12; 95%CI:(1.59-10.71)). For the purpose that careful monitoring hearing capacity and the sound level effect of workers by monitor hearing in order for reducing the initial risk of losing hearing performance and the organization should set up hearing conservation program to prevent loss of hearing.

Keywords: Hearing capacity; Noise level; Worker; Pulp; Paper

1. Introduction

There are a lot of noise pollution that lead to hearing performance and health of workers decrease. Sound is an important ambiance during working and danger of sound can cause stress, loss of hearing and distracting as well. In addition, Noise exposure for long time can be hearing impairment that from the information of World Health Organization (2015) revealed that 360 million of world populations have hearing impairment cause by noise 5% that result in decrease of work ability's workers such as communication skill.

The main cause of Hearing loss is working in a noisy area and in Thailand; Hearing loss is one of the diseases from working. Five Main diseases surveillance of Bureau of Epidemiology B.E.2546-2552 Physical hazard health from working and surrounding found that 60.2% were hearing loss cause by noise. In 2018, there were 42,946 hearing loss 's patient from 76 provinces moreover, from statistics of victim and illness from working B.E. 2554-

2558 revealed that 101 patients were Deafness syndrome.

In Thailand, the pulp and paper industrial is significantly increase for conforming to highly demand that caused by economic growth as same as foreign countries. In Khon Kaen, there has a big pulp and paper industrial that produces and sell such as Packaging paper that is an important material for production including pulp and paper. In the production methods, there are many sort of machines that always generate noise pollution along with the worker can be a hearing loss patient. There are a lot of researches about employee's prevalence of pulp and paper plant found that Sensorineural hearing loss approximated 17.4% from noise exposure for a long time but, in Thailand, There have not had study about health effect from noise pollution in pulp and paper plant therefore the study interested in studying hearing capacity, health effect from sound, frequency and sound level of pulp and paper plant's worker in Khon Kaen.

2. Materials and Methods

2.1 Study design

A Cross-sectional descriptive study population is all of pulp and paper plant's workers by using Stratified Random Sampling totally 286 workers, 8 departments from January to March 2018.

2.2 Sample size

There were 207 samples from 8 departments including raw materials preparation, monitoring and maintenance, pulp production, paper production, instant production, maintenance electricity-paper, maintenance electricity-pulp and maintenance electricity-Energy and Environment as well.

2.3 Tools

- Audiometer, VOYAGER 552

- Sound level meter: SLM, NL-21 Serial No.: 00398417 (Meter), 124757 (Microphone), 30079 (Pre-amplifier), calibrate at the laboratory by calibrator (94 dB(A)).

- Measurement frequency and sound level data.

- Questionnaire from workers that thoroughly went over from three professional divided by 2 sections first is general information of workers and second is effect of health from noise pollution, for quality control there are two expert contents for editing questionnaire.

2.4 Statistical analysis

Descriptive Statistics illustrated information, amount, percentage, maximum-minimum, average and standard deviation. Inferential Statistics used Binary logistic regression by Univariate analysis and presented odds ratio (OR), Adjusted odds ratio (AOR) as well as 95 (95%; CI) of reliability at 0.05 considerable statistics level analyzed by Stata 10.1.

2.5 Ethical consideration

The trial was approved by the Khon Kaen University Ethics Committee for Human Research (Reference Number: HE 612260), 2018.

3. Results and Discussion

A sample was selected from 207 cases that most of the samples were male workers approximately 203 cases (98.70%) and 4 cases of female (1.93%). The average age of samples is 40.58 (S.D=9.51) from diploma 62.32%.

Most of worker work in pulp production department, 20.29%, and next is raw materials preparation about 13.53%.

According to a Characteristic of work, workers control a production process and machine all the time (58.94%) and normally working (45.41%). The average of work experience is 16.72 years (S.D=8.97) and working per day approximates 7.98 h, (S.D=0.84) that less than 8 hours accounted for 98.07 percent and 59.90 percent of working age in department 5-10 years which are shown in the following table1

Studying hearing capacity of 207 samples indicated that normal hearing accounted for 73.91% and 26.09 of unusual that had either of two unusual 66.69% and also found at 4000-

Table 1. Represents number and percent of general information

General information	Number(n=207)	percent (100)
Sex		
male	203	98.70
female	4	1.93
Age		
20-29 years	31	14.98
30-39 years	65	31.40
40-49 years	61	29.47
>50 years	50	24.15
Range = 33, $\bar{x}$ (S.D.) = 40.58 (9.51), Median = 42		
Education		
Elementary school	9	4.35
High school	47	22.71
Diploma/Vocational Certificate	129	62.32
Bachelor's degree	19	9.18
Over Bachelor's degree	3	1.45
Department		
Raw materials preparation	28	13.53
Support and Maintenance	25	12.08
Pulp Production	42	20.29
Paper Production	21	10.14
Instant Production	26	12.56
Maintenance electricity-paper	18	8.70
Maintenance electricity-pulp	20	9.66
Maintenance electricity-Energy and Environment	27	13.04
Characteristic of works		
Work at Production process	73	35.27
control/Maintenance machine	12	5.80
Work at controlling room	122	58.94
Both		
Work shift		
Morning	59	28.50
Evening	40	19.32
Night	14	6.76
Normal	94	45.41

6000 Hz (59.26%) which are shown in the following Table 2.

From hearing capacity effects of samples found the symptoms from sound exposure in each period of time as follows at none working period accounted for 64.25% and found some symptoms including stress (15.46%), mishear when communicating (12.56%) and also stomach ache (13.53%).

During working, sound level influenced health approximately 57.49% were headache, stress as well as mishear, 72.46, 35.75, and 32.85 consecutively.

After working, sound level influenced health therefore there had stress (19.81%), headache (19.32%) and Tinnitus (17.39%) which are shown in the following Table 3.

Studying frequency and sound level in each department and the results of sound level measurement by noise measurement 8 departments (30 points) indicated that department that had the highest average noise (Leq) were maintenance electricity-energy and environment approximately 89.2 dB(A),

raw materials preparation, maintenance electricity-pulp and maintenance electricity-paper department, average noise were 85.6, 85.1, 85.2 dB(A).

An average frequency level in 8 departments found high average frequency level at 1000-2000 Hz. There were raw materials preparation department, pulp production, instant production, maintenance electricity-pulp and maintenance electricity-Energy and Environment that had high average frequency level at 1000 Hz. As follows 79.0 dB(A), 76.2 dB(A), 67.9 dB(A), 73.8 dB(A) and 82.0 dB(A). In part of maintenance department, paper production and, maintenance electricity-paper had the highest average frequency level at 2000 Hz, as follows 64.9 dB(A), 80.1 dB(A) and 78.3 dB(A).

Table 2. Hearing capacity of workers

Hearing capacity of workers *	Number(n=207)	Percent(100)
Normal	153	73.91
Unusual	54	26.09
Type of Unusual		
- Unusual both	18	33.33
- Unusual either of two	36	66.67
Unusual frequency level		
- High frequency (4000-6000 Hz.)	32	59.26
- Frequency at speaking (500-2000 Hz.)	3	5.56
- Unusual both, high and speaking frequency.	19	35.19

* A sample participated research by checking hearing capacity from specialist doctor.

Table 3. Amount and percentage of health effect from sound exposure

Symptoms from sound exposure*	None working period		During working		After working	
	amount (207)	Percent (100)	amount (207)	percent (100)	amount (207)	percent (100)
No symptoms	133	64.25	88	42.51	121	58.45
Have symptoms	74	35.75	119	57.49	86	41.55
- headache	23	11.11	57	72.46	40	19.32
- Dizzy	22	10.63	43	20.77	29	14.01
- earache	12	5.80	33	15.94	21	10.14
- Tinnitus	25	12.08	52	25.12	36	17.39
- Tachycardia	8	3.86	27	13.04	12	5.80
- Stomach ache	26	12.56	33	15.94	28	3.53
- stress	32	15.46	74	35.75	41	19.81
- Stability	18	8.70	36	17.39	25	12.08
- Distraction	23	11.11	46	22.22	31	14.98
- Mishear	28	13.53	68	32.85	35	16.91

* In case of there were the symptoms more than one.

Table 4. Gave an information of relationship between sound level and hearing capacity's workers

Sound level exposure dB(A)	Hearing capacity(person)		Crude OR	Adjusted OR	95% CI of Adjusted OR	P-value
	Normal	Abnormal				
<85 *	91	23	1	1	1.59-10.71	
≥ 85	64	29	1.98	4.12		0.004

* 85 means the sound standard from environmental work referenced from NIOSH, WHO, ACGIH, 2018

Studying a relationship between sound level and hearing capacity's workers found that testing relation between sound level and hearing capacity's workers by using Multiple logistic regression analysis considerably had the relationship between sound level and hearing capacity (Adjusted OR= 4.12; 95%CI=(1.59-10.71)) therefore, the workers that had sound level exposure ≥ 85 dB(A) risk to 4.12 times. Once compared with a sample at lower than 85 dB(A) of sound level exposure shown in Table 4.

4. Conclusions

The group of samples that participated in this study were 207 persons and most of samples were male, approximately 98.70%. Due to the fact that there is a large industries, There used a lot of machines thus male workers were crucially used to monitor and maintenance including their figure that suit to work in those departments more than women, approximately 1.93%. According to hearing capacity, The samples accounted for 73.91% had normal hearing capacity as well as 26.09% of abnormal and types of abnormality were unusual either of two (66.67%), abnormality at high frequency (59.26%) and both abnormality at high frequency and standard frequency of talking (35.19%). From the previous researches revealed that there were a lot of hearing capacity problems in industrial sector that conformed to the study of hearing capacity's workers in sugar industry (Tarnpeam *et al.*, 2007) and accounted for 34.32 of abnormal hearing capacity's workers in granite factory (Jolanun *et al.*, 2006) Found the results of hearing capacity loss around 40% at high frequency that was not more than 50% and the causes of these problems were hearing capacity loss at initial stage at high frequency and hearing capacity loss at low frequency. Labor studying in (Masterson *et al.*, 2007) show some problem of hearing which had a ringing in the ear and hard to listen respectively by 15% and 23% as well as studying at pulp and

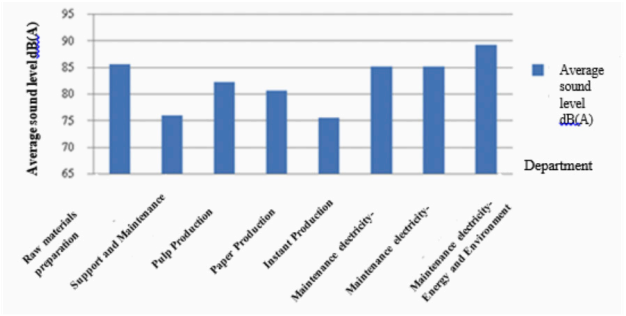

Figure 1. Illustrated sound level measurement in 8 departments

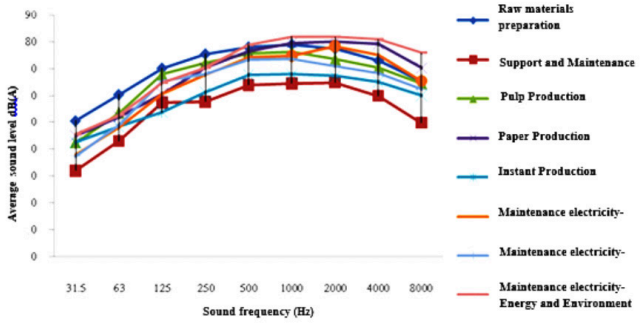

Figure 2. Shows an average sound level measurement in 8 departments

paper- factory in South Africa (Viljoen *et al*., 2007) found 18% of hearing capacity loss that always found at Maintenance department. In addition studying from other research found the hearing capacity loss's trend that considerably increase and from this study found 26.09% of hearing capacity loss because of sound exposure for long time and also ignore to use safety device including exposure at high frequency which affects to auditory system therefore, This is the reason choosing to studied in this factory (noisy from machine). From observation, behavior of sound protection was one of the important results that cause hearing capacity loss thus; entrepreneur must revise risk assessment and protection measures as well as investigated cause of hearing capacity loss (Suthamasa *et al*., 2008). Furthermore, the research finding some strategy which had high efficiency protection of hearing capacity loss was systematical revision in interference efficiency for protecting hearing capacity loss from working (Morata *et al*., 2016)

Health effects from sound exposure of samples conformed to study in workers at compressor motor industry that had health effects from sound exposure such as headache, Insomnia (Chairut *et al*., 2012) and also conformed to Health assessment of workers who work at plastic plant, can factory, food industry, and cutting tools manufactory finding noise pollution during working that cause stress (Omari *et al*., 2013). In addition, High heart rate and high blood pressure was one of the sound exposure effects in automotive industry (Kalantary *et al*., 2015).

Sound levels and frequency in each division and sound measurement at factory totally measured 8 divisions and the highest sound average (Leq) was maintenance electricity-Energy and Environment at 89.2 dB(A) that conformed to department of Labour Protection and welfare standard of criterion and sound conservation project method at industry B.E 2553. Department of Labour Protection and welfare allocated if average sound level for 8 hours a day more than 85 dB(A) , employer must set up hearing conservation project in factory. The division that had the lowest sound average (Leq) was finished product division at 75.5 dB(A) because in this division, there are many workers more than machines that caused sound average in this division was less than others. In case of average frequency measurement revealed that every division complied with the standard according to specified regulations and conformed to noise pollution study (Menchai *et al*., 2010). Measurement in working area by using Sound level meter: SLM at Bis pipe fitting industry measured and compared with Ministry of industry announcement found that average sound levels was 81.0 – 98.1 dB (A) and also found some case study of hearing capacity loss at manufacturer of Rubber wood (Kongthong *et al*., 2007). Measured sound level by using Sound level meter and compared with standard as well. Sound frequency study at cement factory in China (Cafeng *et al*., 2012) found sound frequency as same as this study and all the results of measurement was more than 85 dB(A) since sorts of industries had noise pollution but, study in Ghana (Gyamfi *et al*., 2016) found measurement by isolation machines in Mining industries had sound level between 85 to 103 dB(A) that was different from previous study as earlier studies were sound level measurement at surrounding during working along with from academic study found some sound control idea (Suthamasa, *et al*., 2008) by the best method was sound control at source by engineering methods and next, control at bypass of sound and the last one, workers control respectively together with factory had sound level control at sound sources and other protect.

The relationship between sound level and hearing capacity of workers in pulp and paper factory revealed that sound levels considerably had relation with hearing capacity in statistic (Adjusted OR= 4.12, 95%CI= 1.59-10.71) that conformed to study of relation in woven factory (Jamarikan *et al*., 1997) found a relation between hearing capacity loss and sound exposure in statistical significance (P-value=0.00018). Study in Metal industry (Whittaker *et al*., 2014) found the same result that sound level had relation with hearing capacity of employee, comparing with control group (OR=10.3). From study in melt metal industry (Singhapoom *et al*., 2013) found that workers that exposure with sound at

< 85 dB(A) and ≥85 dB(A) did not have relation with hearing capacity loss (P-value=0.281) this might cause by limit data collection because the samples that received sound at > 85 dB(A) used personal protection device this is the reason, why sound exposure did not affect hearing capacity.

5. Research limitations

Auditing hearing capacity loss of workers because of the firm had specialist physician check hearing capacity. Design of this study was cross sectional descriptive thus there can not show cause and effects.

6. Recommendations

The workers that had to work for long time with sound should aware of occupational health and safety policy (exp. Some workers ignored wear PPE; ear plug or ear muffs) and monitor hearing capacity, sound level, and health effect of employee by monitoring and following hearing capacity of pulp-paper factory's employee annually in order to look for the risk of initial hearing capacity loss and should look to other risk that occurred by sound exposure for long time. Organization should set up hearing conservation project to protect hearing capacity loss including found some activities in order to educate about danger of sound and encounter to use protection device so that reduce risk of hearing capacity loss.

Recommendations for further research

1. Study about participants who got abnormal health effect such as routine heath checkup.

2. Study others risk factors and how to prevent these risk factors by factory or related organization.

3. Next study should study relationship between hearing capacity and health effect which causes by sound exposure of employee and study other risk factors that affect hearing capacity loss.

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