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Factors Associated with Occupational Hearing Loss among Stone-Mortar Workers in Phayao Province, Northern Thailand

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Abstract:

Objective: Noise pollution is an unwanted phenomenon that affects human health and can lead to occupational hearing loss in exposed workers. The stone-mortar industry is one of the processes which can create a noise hazard. This study aimed to explore the factors associated with occupational hearing loss among stone-mortar workers in Phayao Province, Northern Thailand.

Material and Methods: A cross-sectional study was conducted 27 stone-mortar workers who were interviewed with a questionnaire. Pure-tone hearing thresholds were measured using audiometry. The data were analyzed using Mann-Whitney U test, Spearman's rank correlation test and Kruskal-Wallis test and Multiple linear regression analysis.

Results: The study found a significant difference between age and high frequency hearing loss in both right and left ears (p-values 0.024 and 0.049, respectively). There were significant correlations between working hours per day and high frequency hearing loss in both right and left ears (p-values 0.030 and 0.042, respectively). Multiple linear regression analysis found increasing age was associated with high frequency hearing loss in both right and left ears (p-values 0.033 and 0.017, respectively) after adjusting for number of years worked, working hours per day, and use of personal protective equipment as random variables.

Conclusion: All stone-mortar factories produce noise pollution. Therefore, the local policy makers should emphasize reducing noise pollution from stone factories and surveillance of occupational hearing loss to improve the quality of life of the people who work in such factories.

Keywords: occupational hearing loss, stone-mortar workers

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Introduction

Noise pollution is a major environmental risk to human health and quality of life. Exposure to noise can cause adverse health effects, including increased risk of cardiovascular diseases, hypertension, psychological effects and hearing loss in workers and people living close to noise sources.[1-6] A study from India reported that the level of disabling hearing loss in adults was 16.0% worldwide, ranging from 7.0% to 21.0% in various subregions.[7] There are both natural and artificial sources of noise pollution, arising from things such as exploitation of natural resources, construction, transportation,agriculture, and industrial activities.[8-10]

Short-term exposure to loud noise can also cause temporary hearing loss. Long term exposure to loud noise can lead to permanent hearing loss through damage to the inner ear (cochlea) or auditory neural system.[5,11,12]

In Thailand, noise-induced hearing loss is a significant health problem in the industrial and agri-cultural industries.[8,13] One such industry is the stone-mortar industry, which depends largely on informal labor with lack of access to health services and preventive programs.[8,14] The stone mortar factories generate loud noise from the production process and use machines which create various types of noise pollution. Early detection of hearing loss is a necessary step in providing appropriate control and health system programs for people who have suffered hearing loss. Therefore, we aimed to assess frequency hearing levels among stone-mortar workers in Phayao province, northern Thailand.

Material and Methods

This study was a cross-sectional study to explore factors associated with occupational hearing loss among stone-mortar workers, conducted from July to August 2018 in Ban Sang sub-district, Phayao province, Thailand. We enrolled 27 subjects from all available stone-mortar workers by using a purposive sampling method. The inclusion criteria were subjects who were 18 years old and above and had worked in a stone-mortar factory for at least one year. Workers who could not verbally communicate in the Thai language or who had neuropathy were enrolled.

All participants signed informed consent forms before data collection. The study was approved by the Research Ethics Committee of the University of Phayao, Thailand (No. 2/029/61). The questionnaire gathered information on the demographic and work characteristics of the participants, including sex, age, education, marital status, income, number of years worked and working hours per day, and use of personal protective equipment (PPE).

Pure-tone hearing thresholds at the frequencies of 500, 1,000, 2,000, 3,000, 4,000, 6,000 and 8,000 Hertz (Hz) were measured using audiometry (Manufacturer: ENTOMED screening audiometer, Model: SA201). Frequency averages of 500, 1,000, and 2,000 Hz were classified as low frequency, while frequency averages of 3,000, 4,000, and 6,000 Hz were classified as high frequency.[9,15] The cutpoint for hearing loss did exceed safe cut-off levels recommended by Occupational Safety and Health Adminis-tration (OSHA) guidelines [25 decibels (dB) or more].[16-18]

The data were analyzed using the R program. Mann-Whitney U test, Spearman's rank correlation test and Kruskal-Wallis test were used to compare demographic characteristics (sex, age education, marital status, income, number of years worked, working hours per day, and use of PPE). Multiple linear regression analysis was used to analyze the association between age and high frequency hearing levels. Statistical significance was set at p-value< 0.05.

Results

The participants were 24 males (88.9%) and 3 females (11.1%). The average age was 51.1 years with an

average income of 7,347.8 baht per month and an average of 18.8 years worked. The most common personal protective equipment used were ear plugs 14 respondents, 51.9%, cotton balls 10 respondents, 37.0%, and ear muffs 3 respondents, 11.1% (Table 1).

The study found that the average hearing levels of the right and left ears were decreased at 500, 3,000, 4,000, 6,000, and 8,000 Hz when compared with a hearing loss of up to 25 decibels.[16–18] The average hearing level of both right and left ears were normal at 1,000 and 2,000 Hz. The cutpoint for hearing loss did exceed safe cut-off levels recommended by OSHA guidelines (25 dB or more) (Table 2).[16–18]

Table 1 Characteristics of study participants (n=27)

Characteristic	Number (%)
Sex	
Male	24 (88.9)
Female	3 (11.1)
Age (years), mean±S.D.	51.1±8.8
<60	22 (81.5)
≥60	5 (18.5)
Education	
≤Primary school	22 (81.5)
>Primary school	5 (18.5)
Marital status	
Married	26 (96.3)
Single/divorced	1 (3.7)
Income (baht/month)	7,347.8±2,166.0
<7,500	13 (48.1)
≥7,500	14 (51.9)
Number of years worked	18.8±15.1
<10	11 (40.7)
≥10	16 (59.3)
Working hours per day	7.2±1.5
Personal protective equipment	
Cotton balls	10 (37.0)
Ear plugs	14 (51.9)
Ear muffs	3 (11.1)

S.D.=standard deviation

Table 2 Average hearing levels at varying frequencies (Hz)

Variable	Frequency (Hz)	Mean±S.D.	Min–Max
Right ear	500	30.6±7.4	15–50
	1,000	20.9±6.2	10–30
	2,000	19.6±12.7	0–50
	3,000	32.6±19.7	0–70
	4,000	42.4±20.2	0–75
	6,000	43.0±24.9	0–85
	8,000	41.1±24.4	0–85
Left ear	500	28.7±8.6	0–95
	1,000	18.0±6.8	10–30
	2,000	16.7±10.5	0–50
	3,000	29.6±18.9	5–65
	4,000	41.5±18.4	0–70
	6,000	43.0±24.7	0–85
	8,000	38.9±23.5	5–85

Hz=hertz, S.D.=standard deviation, Min=minimum, Max=maximum

The average high frequency hearing losses of the right and left ears were 39.3±18.9 and 38.0±17.9 dB, respectively. Average low frequency hearing losses of the right and left ears were 23.7±7.7 and 21.1±6.9 dB respectively. The cutpoint for hearing loss did exceed safe cut-off levels recommended by OSHA guidelines (25 dB or more) (Table 3).[16–18]

The study found a significant difference between age and high frequency hearing loss of the right and left ears (p-values 0.024 and 0.049, respectively). There were significant differences between sex and high frequency hearing loss of the right ear (p-value=0.034). Moreover, there was significant correlation between working hours per day and high frequency hearing loss in both right and left ears (p-value=0.030 and p-value=0.042, respectively) (Table 4).

Table 3 Average hearing levels of low and high frequencies (Hz)

Hearing level	Mean±S.D.	Min–Max
Right ear		
Low frequency	23.7±7.7*	8.3–40.0
High frequency	39.3±18.9*	6.7–73.3
Left ear		
Low frequency	21.1±6.9*	10.0–40.0
High frequency	38.0±17.9*	5.0–70.0

Hz=hertz, S.D.=standard deviation, Min=minimum, Max=maximum, *Low frequencies in right and left ears compared with high frequency by Spearman's rank correlation test with p-value<0.05

The multiple linear regression analysis showed that increased age was not associated with low frequency hearing loss in either ears (right and left ears p-value= 0.272 and p-value=0.065, respectively) after adjusting for number of years worked, working hours per day, and personal protective equipment as random variables (Table 5).

The multiple linear regression analysis showed that increased age was associated with high frequency hearing loss of both ears (right and left ears p-value=0.033 and p-value=0.017, respectively) after adjusting for number of years worked, working hours per day, and personal protective equipment as random variables (Table 6).

Table 4 Factors associated with low frequency and high frequency hearing levels

Characteristic	Low frequency (p-value)		High frequency (p-value)	
	Right ear	Left ear	Right ear	Left ear
Sex[a]				
Male	0.333	0.130	0.034*	0.177
Female				
Age (years)[a]				
<60	0.042*	0.109	0.024*	0.049*
≥60				
Education[a]				
≤Primary school	0.150	0.103	0.169	0.080
>Primary school				
Marital status[a]				
Married	0.334	0.272	0.440	0.521
Single/Divorced				
Income (baht/month)[a]				
<7,500	0.609	0.733	0.981	0.356
≥7,500				
Number of years worked[a]				
<10	0.255	0.107	0.079	0.026*
≥10				
Working hours per day[b]	0.223	0.267	0.030*	0.042*
Hours working (per day)[b]	0.470	0.162	0.872	0.970
Personal protective equipment used[c]				
Cotton balls	0.076	0.243	0.444	0.541
Ear plugs				
Ear muffs				

[a]Presented in Mann-Whitney U test, [b]Spearman's rank correlation test, [c]Kruskal-Wallis test, *p-value<0.05

Table 5 Association between age and low frequency hearing levels using multiple linear regression analysis

Associated factors (n=27)	Low frequency of right ear			Low frequency of left ear		
	B	SE	p-value	B	SE	p-value
Age (years)	0.207	0.183	0.272	0.332	0.171	0.065

Adjusted for number of years worked, working hours per day, and personal protective equipment as random variables, *p-value<0.05, B=beta, SE=standard error

Table 6 Association between age and hearing level in high frequency using multiple linear regression analysis

Associated factors (n=27)	High frequency of right ear			High frequency of left ear		
	B	SE	p-value	B	SE	p-value
Age (years)	1.026	0.450	0.033*	1.083	0.420	0.017*

Adjusted for number of years worked, working hours per day, and personal protective equipment as random variables, *p-value<0.05, B=beta, SE=standard error

Discussion

The stone-mortar industry is an informal labor sector which generates very loud noise during the production process. Long term exposure to this noise affects physical health, mental health and quality of life, including leading to various diseases such as tinnitus, cardiovascular disease, hypertension, and hearing loss.[19-23]

Our study found that most stone-mortar workers used ear plugs (51.9%) or cotton balls (37.0%) to try to reduce their noise exposure. Previous studies have found that most workers lacked awareness about noise-induced hearing loss. Thus, hearing protectors should be provided engineering controls, administrative controls, and work practices for reducing noise exposure to safe levels.[1,8,12]

Our study found that average high frequency hearing loss of both right and left ears were higher than those of OSHA guidelines (25 decibels).[16-18] The average age of the stone-mortar workers in our study was 51.1 years, and we found a significant difference between age and high frequency hearing loss of right and left ears. Our study found that there was a significant correlation between working hours per day and high frequency hearing loss of both ears. Moreover, the multiple linear regression analysis showed that increased age was associated with high frequency hearing loss of both ears. These findings were consistent with our findings that association of age, long working hours and hearing impairment in high frequencies. Therefore, there are many possible confounding the possible confounding variables due to unmeasured factors.[24,25]

The main limitation of this study was its cross-sectional design exploring risk factors among the study group, stone-mortar workers, but with no control group. Therefore, a longitudinal study is needed to confirm if there actually is a causal relationship between risk factors such as noise exposure level and occupational hearing loss.

Conclusion

Noise pollution is an unwanted phenomenon that affects human health and occupational hearing losses in exposed workers. Our results suggest that age and working time period are the strongest risk factors for this type of hearing loss. Therefore, concerned government maybe provide protection devices for at-risk workers. In addition, policy local makers should emphasize reducing noise pollution from stone factories and surveillance of occupational hearing loss to improve the workers' quality of life.

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Conflict of interest

None

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