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Original Article

Assessment of Noise Exposure and Hearing Loss Among Workers in Textile Mill (Thamine), Myanmar: A Cross-Sectional Study

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ABSTRACT

Background: In a wide range of industries, noise-induced hearing loss remains one of the most prevalent occupational problems. This study aimed to assess the noise exposure level and associated factors of hearing loss among textile workers in Yangon Region, Myanmar.

Methods: A cross-sectional study was conducted at a Textile mill (Thamine), Yangon Region, from April to December 2018. In total, 226 workers who were randomly selected from 3 weaving sections participated in face-to-face interviews using a structured questionnaire. A digital sound level meter and pure-tone audiometer were used for the assessment of noise exposure level and hearing loss, respectively. Logistic regression analysis was performed to assess the associated factors of hearing loss.

Results: In total workers, 66.4% were exposed to ≥ 85 dB(A) of noise exposure, and the prevalence of hearing loss was 25.7%. Age ≥ 35 years, below high school education, hearing difficulty, tinnitus, hypertension, > 9 years of service duration in a textile mill were positively associated with hearing loss. After adjusting confounding factors, age ≥ 35 years (adjusted odds ratio = 6.90, 95% confidence interval = 3.45–13.82) and tinnitus (adjusted odds ratio = 2.88, 95% confidence interval = 1.13–7.37) were persistently associated with hearing loss.

Conclusion: Providing occupational hazard education and enforcement of occupational safety regulations should be taken to decrease the noise exposure level. The regular audiometry test should be conducted for assessment of hearing threshold shift. The employer needs to implement a hearing conservation program in workplace when noise exposure reaches or exceeds 85 dB(A) for 8 hours.

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1. Introduction

Globally, hearing loss is the fourth highest cause of disability, and it is estimated that there are around 466 million people with disabling hearing loss [1]. In developing countries, occupational noise exposure is a second most self-reported occupational illness with functional, social, emotional, and economic impacts on industrial workers [2]. Noise-induced hearing loss (NIHL) is an occupational hazard, especially faced by textile workers [3]. It is

caused by exposure to sound levels or durations that damages the hair cells of the cochlea and may be well advanced by the time that it gives rise to appreciable disability [4]. It can develop gradually over time with exposure to excessive noise produced from manufacturing industries [5].

Noise is any unwarranted disturbance within a useful frequency band, such as undesired electric waves in a transmission channel or device [6]. It is commonly classified as environmental noise and occupational noise by assessing its impact on human well-being.

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Occupational noise is the insidious of all industrial pollutants which are involving every industry. Exposure to excessive occupational noise can cause hearing loss which is a partial or complete hearing loss in one or both ears as the result of employment [7]. Worldwide, 16% of the disabling hearing loss in adults is attributed to occupational noise [8].

Exposure to sudden impulse noise is more detrimental than exposure to steady state noise, and single or repeated sudden noise exposure is generally referred to as acoustic trauma [9]. Depending on the level and duration of the exposure, noise trauma can result in 2 types of injury to the inner ear: temporary threshold shift (TTS) and permanent threshold shift [10]. The recovery of TTS is probably a result of reversible uncoupling of the outer hair cell stereocilia from the tectorial membrane [11]. The characteristic pathological feature of NIHL with permanent threshold shift is particularly the prominent loss of outer hair cells at basal turn. A sufficient level and duration of noise may disrupt the hair cells and the entire organ of Corti [10].

The human ear is not equally sensitive to sounds at different frequencies. A spectral sensitivity factor is used to weight the sound pressure level at different frequencies (A-filter) to assess the perceived loudness of a sound. These A-weighted sound pressure levels are expressed in units of decibels, dB(A) [6]. The National Institute for Occupational Safety and Health (NIOSH) recommends that a recommended exposure limit for occupational noise exposure is 85 dB(A), as an 8-hr time-weighted average (8-hr TWA). Exposures at and above this level are considered hazardous noise levels [6,12].

The effects of the exposure to occupational noise are larger for men than for women in developing countries [13]. Hearing loss due to continuous or intermittent occupational noise exposure increases rapidly during the first 10 to 15 years of exposure [14]. Subsequently, noise exposure level, age, smoking, elevated blood pressure and employment duration were certainly associated with hearing loss [15–18]. It can also contribute psychological stress and disruption of job performance [6]. Pure-tone testing is the measurement of an individual's hearing sensitivity to calibrate pure tones at different frequencies. A pure-tone audiometer can identify hearing threshold levels and determine hearing loss among workers exposed to occupational noise [19]. The values of the thresholds are inserted into the audiogram which is a fundamental description of auditory sensitivity. It helps to determine hearing ability: normal limit (0–25 dB) and hearing loss (>25 dB) [6].

Although hearing loss can be completely preventable, accessibility of health-care services and prevention program is still limited in majority of Asian developing countries. The lack of awareness about NIHL among employers and employees is one of the main barriers for the prevention of NIHL in Asia [20]. Some weakness in development and implementation of hearing conservation programs including noise level reduction, regulation development, and use of personal protective devices (PPDs) in occupational settings are main challenges to mitigate the occurrence of NIHL [1]. In Myanmar, there is no program for prevention of deafness and hearing loss coordinated at the national level, and the Committee on Prevention and Control of Deafness initiates steps for the protection of hearing in the industrial sector [21]. The main objectives of this study were to explore the level of noise exposure and to assess factors associated with hearing loss among workers in Textile Mill (Thamine), Yangon Region, Myanmar.

2. Materials and methods

2.1. Study design, area, and period

A cross-sectional descriptive study was conducted on workers at Textile Mill (Thamine), Yangon Region, from April to December

2018. There were 1600 workers in 12 sections of the textile mill, and they were exposed to excessive noise, heat, dust, and chemical in the workplace.

2.2. Sample size and sampling techniques

The sample size was determined by a single population proportion formula using the proportion of hearing loss of 0.26 from the study conducted in Turkey [22], with a margin of error of 0.06 and Z score for 95% confidence interval (CI) of 1.96. Then, a 10% nonresponse rate was added, and the final sample size was 226. A multistage sampling technique was used to select the participants. Firstly, 3 noisiest weaving sections (water jet loom, towel loom, and bed sheet loom) were selected by purposive sampling. Secondly, 75 participants from 187 workers in the water jet loom section, 75 from 174 workers in the towel loom section, and 76 from 109 workers in the bed sheet loom section were selected by simple random sampling. The workers who did not give informed consent, those who suffered hereditary hearing loss, those who had head injury and ear infection, those who were exposed to ototoxic drugs and chemicals, and those who were exposed to occupational noise less than 12 hours before audiometric assessment were excluded.

2.3. Materials, techniques, and procedures

The data were collected through interviews, measuring noise level and assessing hearing loss. The participants were interviewed face to face by 2 interviewers using structured questionnaires. The questionnaire was constructed with 4 parts. Demographic factors such as gender, age, educational status, and current section were the first part; risk behaviors such as smoking, alcohol drinking, and loud music listening were the second part; health problems such as hearing difficulty, tinnitus, headache, earache, hypertension, and diabetes mellitus were the third part; and factors related with noise exposure such as duration of service in the textile mill, duration of service in the current section, duration of daily occupational noise exposure, use of PPD, and noise exposure level were the fourth part. For the content validity, the questionnaire was pretested in a textile mill of Hlaing Tharyar Township that was not selected for the study. The homogeneity of questionnaire was fair to strong with high Cronbach α ranging from 0.70 to 0.82.

The measurement of noise exposure level in each sections was performed by a hygiene officer using a Type 2 digital sound level meter (Extech 407,732, 35 to 130 dB in 2 ranges with accuracy of plus or minus 1.5 dB) which was a product of Extech Instruments, United States. The device was placed at least 1 meter from the noise source. The officer hold it by facing the microphone toward the noise source and viewed the measurement on the liquid crystal display (LCD). Noise exposure level was measured as a mean value of 15 measurements hourly during working time for 8 hours because the production process was not consistent, and the 8-hr TWA was recorded. Then, the average noise exposure level of 8-hr TWA on 5 separate days was taken for each weaving section.

The assessment of hearing loss was performed by using a pure-tone audiometer (Model – AS5-AOM, 08026 Barcelona-Spain, Sibelmed), a recommended device of Occupational Health and Environmental Division, Department of Public Health under the Ministry of Health and Sports. The audiometric test was performed by a trained technician from the Occupational and Environmental Division to minimize observer bias. A participant and technician were only allowed for each test in the examination room, and the level of ambient noise (less than 35 dB) was recorded. All audiometric tests were assessed before the workers moved in their section to avoid the effects of TTSs. To identify hearing loss, an

Table 1
Background characteristics of textile workers

Variables	Frequency (%)
Demographic factors	
Gender	
Male	15 (6.6)
Female	211 (93.4)
Age	
<35 years	132 (58.4)
≥35 years	94 (41.6)
Mean ± SD (35.42 ± 11.63), minimum 18, maximum 59	
Educational level	
Read and write	1 (0.4)
Primary school education level	10 (4.4)
Middle school education level	47 (20.8)
High school education level	129 (57.1)
Graduate and above	39 (17.3)
Current weaving section	
Water jet loom	75 (33.2)
Towel loom	75 (33.2)
Bed sheet loom	76 (33.6)
Risk behaviors	
Smoking	
No	217 (96.0)
Yes	9 (4.0)
Alcohol drinking	
No	223 (98.7)
Yes	3 (1.3)
Loud music listening	
No	189 (83.6)
Yes	37 (16.4)
Health problems	
Hearing difficulty	
No	210 (92.9)
Yes	16 (7.1)
Tinnitus	
No	201 (88.9)
Yes	25 (11.1)
Headache	
No	208 (92.0)
Yes	18 (8.0)
Earache	
No	213 (94.2)
Yes	13 (5.8)
Hypertension	
No	184 (81.4)
Yes	42 (18.6)
Diabetes mellitus	
No	221 (97.8)
Yes	5 (2.2)
Factors related with noise exposure	
Duration of service in textile mill	
≤9 years	115 (50.9)
>9 years	111 (49.1)
Duration of service in current section	
≤9 years	154 (68.1)
>9 years	72 (31.9)
Noise exposure level	
<85 dB(A)	76 (33.6)
≥85 dB(A)	150 (66.4)

SD, standard deviation.

otolaryngologist assessed the audiograms, and then an occupational physician confirmed the diagnosis of hearing loss.

2.4. Operational definitions

Alcohol drinking is defined as history of drinking habitually, and no alcohol drinking is no history of drinking or just stopped drinking at least 2 years prior. Smoking is defined as history of smoking habitually (cigarettes or cigars), and no smoking is no history of smoking or just stopped smoking at least 2 years prior. Loud music listening means listening to loud music through earbuds connected to devices such as media player. Duration of service

in textile mill is defined as the total number of working years in textile mill. If a decimal was greater than 6 (months), the length was counted as 1 (year) and equal 0 if less than 6 (months). Duration of service in current section is the total number of working years in current weaving section. If a decimal was greater than 6 (months), the length was counted as 1 (year) and equal 0 if less than 6 (months). Noise exposure level is the dB(A), usually averaged over an 8-hour working day, was classified at greater than 85 dB(A) as high noise exposure and lower than 85 dB(A) as low noise exposure. PPD utilization is the action of wearing ear plugs or earmuffs to protect noise exposure in workplace. A pure-tone audiometer was used to determine the hearing thresholds in the frequencies of 0.25, 0.5, 1, 2, 3, 4, 6, and 8 kHz for both ears of all workers. The measurement of hearing thresholds was carried out in 5 dB increments. The workers were considered to have hearing loss if the average hearing thresholds in the frequencies of 4, 6, and 8 kHz had been recorded for more than 25 dB in each ear [23].

2.5. Statistical analysis

The collected data were checked for the completeness, correctness, and relevance. Data were entered into Excel 2013 and then cleaned and exported to the Statistical Package for Social Sciences program, version 23, for analysis. Data summarization was performed by using tables, charts, and graphs. Descriptive statistics were presented as frequency (percentages) for categorical variables and mean [standard deviation (SD)] for continuous variables. The results of a sound level meter in each weaving section by measuring 5 consecutive days were presented as mean value and SD. The differences between means of noise exposure in weaving sections were calculated by using one-way analysis of variance with a post-Hoc Tukey HSD test. Bivariate logistic regression analysis was performed on each independent variable, and respective crude odds ratio (COR) was calculated. To control confounding factors, multivariate analysis was performed by the forward conditional logistic regression model including only significant variables after bivariate analysis to detect the related factors of hearing loss. The significant association of independent variables with dependent variables was assessed by using 95% CI and respective adjusted odds ratio (AOR). A two-tailed-sided p-value < 0.05 was considered statistically significant.

3. Results

3.1. Background characteristics of workers

A total of 226 workers from 3 weaving sections were selected. As shown in Table 1, 93.4% were women and only 6.6% were men. The mean age was 35.42 (SD ± 11.63) years with the range of 18–59 years and 58.4% were younger than 35 years. For educational level, 57.1% had a high school education, and 17.3% were graduate and above. With regard to current weaving sections, each of 33.2% was in water jet loom and towel loom, respectively, and 33.6% were in bed sheet loom. Of all workers, 4% were smokers, 1.3% were drinkers, and 16.4% gave the fact that they listened music loudly. Regarding health problems, 7.1% suffered hearing difficulty, 11.1% suffered tinnitus, 8% got headache, and 5.8% got earache. Moreover, 18.6% had hypertension and 2.2% had diabetes mellitus. Overall, 49.1% had more than 9 years of service duration in a textile mill and 31.9% had more than 9 years of service duration in the current section. All workers were working an 8-hour work shift every day, and they did not use PPDs during working hours.

3.2. Noise level exposed to workers

Among the workers, 66.4% were exposed to ≥ 85 dB(A) and 33.6% were exposed to < 85 dB(A) of noise exposure. The noise level in each weaving section was shown in Fig. 1. The means (\pm SD) noise exposure as an 8-hr TWA were 94.70 (± 0.70) dB(A) with the range of 92.4–95.7 dB(A) in water jet loom, 93.49 (± 1.14) dB(A) with the range of 89.2–95.1 dB(A) in towel loom, and 84.73 (± 1.21) dB(A) with the range of 80.0–86.9 dB(A) in bed sheet loom. A statistically significant difference was found among three weaving sections on noise exposure, $F(2, 117) = 1086.38$, $p = < 0.001$.

3.3. Hearing loss among workers

Table 2 showed hearing loss among workers. Of all workers, 25.7% had hearing loss and 74.3% were normal. Among the workers with hearing loss, 48.3% got hearing loss on both sides, 31% on the right side, and 20.7% on the left side. The hearing threshold level more than 25 dB at high frequencies in left and right ears are shown in Fig. 2.

3.4. Factors associated with hearing loss

The factors associated with hearing loss are shown in Table 3. The workers who were aged 35 years and older (COR = 7.42, 95% CI = 3.73–14.73), those who had less than high school education level (COR = 2.24, 95% CI = 1.18–4.27), those who suffered hearing difficulty (COR = 5.63, 95% CI = 1.95–16.27), those who suffered tinnitus (COR = 3.76, 95% CI = 1.60–8.80), those who had hypertension (COR = 3.97, 95% CI = 1.97–8.03), those who had more than 9 years of service duration in the factory (COR = 6.07, 95% CI = 2.99–12.32) were significantly associated with hearing loss. As an adjusting for the impact of confounding factors, the workers who were aged 35 years and older (AOR = 6.90, 95% CI = 3.45–13.82) and

Table 2
Hearing loss among textile workers

Variables	Frequency (%)
Hearing loss (n = 226)	
Absent	168 (74.3)
Present	58 (25.7)
Effected side of loss (n = 58)	
Both sides	28 (48.3)
Right side	18 (31.0)
Left side	12 (20.7)

those who suffered tinnitus (AOR = 2.88, 95% CI = 1.13–7.37) were significantly associated with hearing loss.

4. Discussion

NIHL is the only type of hearing loss that is completely preventable, but it is remaining as a significant health problem with economic consequences in South East Asia countries [24]. The result of the study showed that the mean age of the workers was 35.42 years with the range of 18–59 years. This finding was consistent with other studies carried out in Ethiopia with 34.3 years of mean age [25] and in Thailand with 33.8 years of mean age [26]. The studies conducted in Thailand [17], Turkey [22], and India [27] showed that most workers were aged 31–40 years. According to the nature of labor intensive employment, young workers were the main contributors in production sectors of most industries.

All workers in weaving sections operated at an 8-hour work shift in the textile mill. Similarly, a study conducted in Pakistan showed that the duration of work in each shift was 8 hours per day with daily break of 72 minutes [28]. It was also consistent with the recommended exposure limit for noise that was recommended by the NIOSH. According to Factories Act 1951, normal working hours in Myanmar were not to exceed 8 hours a day or 44 or 48 hours (for

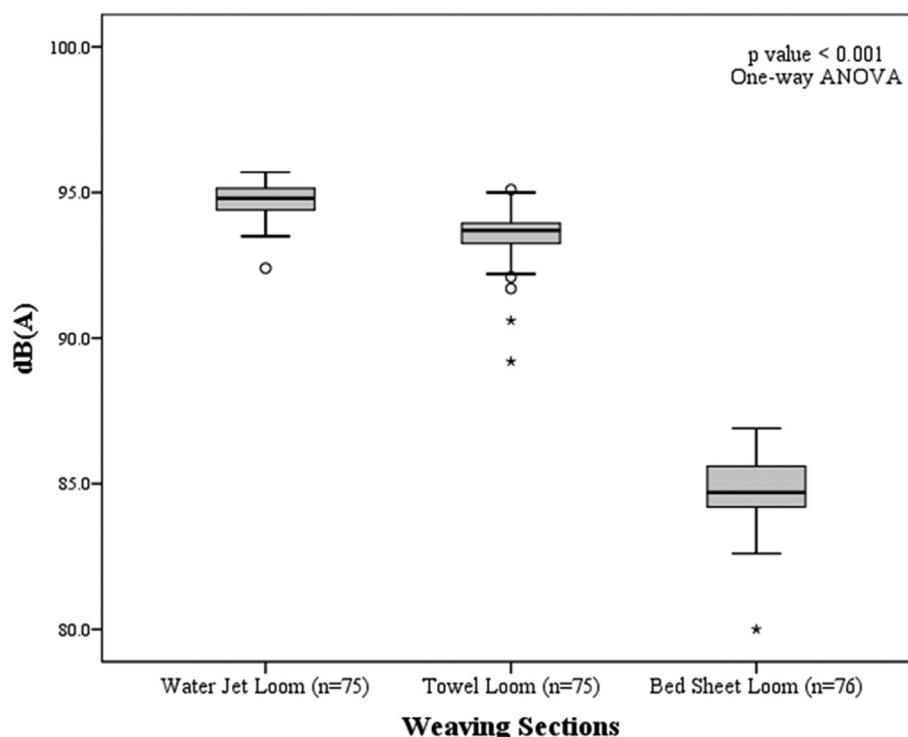


Fig. 1. Noise exposure as an 8-hr TWA among textile workers (n = 226) in weaving sections. 8-hr TWA, 8-hr time-weighted average.

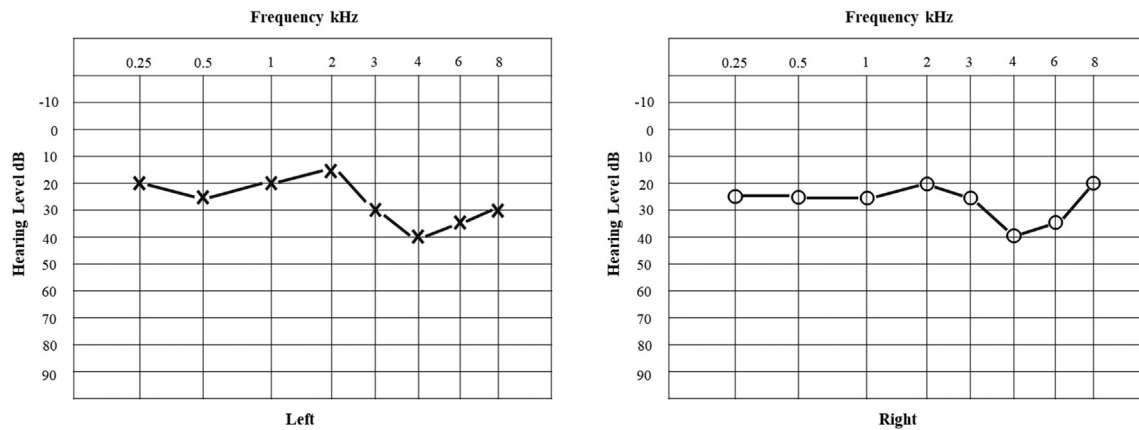


Fig. 2. Audiograms showing results more than 25 dB in high frequencies for left and right ears.

continuous process) a week which was standardized by the International Labor Organization Law. Most workers had less than 10 years of service duration in the textile mill. This finding was also consistent with similar studies conducted in Bangladesh [29] and Turkey [22]. However, the other studies stated that more than 10 years of service duration occurred in a large proportion of workers [26,27].

For reducing noise exposure to safe levels, hearing protectors such as earmuffs, ear plugs, and ear canal caps should be used when engineering controls and work practices were not feasible [8]. In this study, there was no worker wearing PPDs in the workplace, although providing PPDs to them. It might be suggested that the workers had poor awareness on NIHL and self-protective measure by using PPDs at the workplace. The similar study conducted in Nigeria stated that most of unprotected workers reported hearing loss [3]. Therefore, the enforcement of occupational safety and health regulations should be performed to wear hearing protectors in the workplace when they exposed to noise that equals or exceeds 85 dB(A) as an 8-hr TWA.

The workers exposed to more than 85 dB(A) of noise level were in water jet loom and towel loom sections. The means of noise exposure were 94.7 dB(A) in the water jet loom section, 93.5 dB(A) in the towel loom section, and 84.7 dB(A) in the bed sheet loom section. Similar study carried out in Myanmar found that mean noise exposure was 91.94 dB(A) in the weaving section and 85.61 dB(A) in the spanning section [30]. In addition, other studies showed that mean sound levels of weaving sections were 87.3 dB(A) in India [27], 95.3 dB(A) in Pakistan [28], and 99.5 dB(A) in Ethiopia [25]. It could be suggested that weaving sections had the highest noise level, and it might be hazardous to workers.

The prevalence, 25.7%, of hearing loss in this study was lower than 30% found in the studies conducted in Jordan [31], 30.86% in Turkey [22], 33.46% in Bangladesh [29], 34% in Ethiopia [25], 35% in Canada [32], and 38% in India [27]. However, it was higher than 22.5%, which found in the study carried out in Pakistan [28]. These differences of hearing loss may have resulted from the use of hearing loss prevention programs for all workers whose unprotected 8-hr TWA exposures equal or exceed 85 dB(A) with assessment of noise exposure and audiometric monitoring.

Age-related hearing loss was one of the most common causes of high frequency hearing loss, and its effect began around the age of forty [16,28]. In this study, the workers aged 35 years and older were 7 times more likely to have hearing loss than those who were younger than 35 years. This observed association persisted after adjusting the service duration, and it was consistent with a study carried out in Ethiopia [25]. This might be due to a phenomenon of

presbycusis which was gradually loss of hearing in older age. Similar studies conducted in India [27], Canada [32], and Brazil [16] documented that age was positively associated with hearing loss.

The workers who had less than a high school education level were at greater risk of developing hearing loss than those who had a high school education level and more. This may be due to the fact that the workers who had low education level were unable to follow safety policies, to conscious in warning labels and instructions of machines, and to cooperate in hazard communication programs. Hearing difficulty is also an associated factor of hearing loss. It can be suggested that loud noise can damage the inner ear and impact day-to-day communication at workplaces as a result of difficulty to understand speech among workers. A similar condition was observed in Great Britain in which high prevalence of severe hearing difficulty among noise-exposed workers was observed [33].

Tinnitus is a considerable problem for noise-exposed workers, and it can adversely affect sleep, concentration, mood, and quality of life as a minor annoyance [34]. Exposure to loud noise can develop tinnitus, and then it can progress hearing loss. The workers with hearing loss will not notice changes in hearing ability until a large threshold shift has occurred. It is irreversible and increases in severity with continued exposure [23]. In this study, the workers who reported current tinnitus were 3 times more likely to develop hearing loss than those who did not report. This finding was in agreement with the different study conducted in Canada that reported high prevalence of tinnitus among hazardous noise-exposed workers [32].

Regarding high blood pressure, a higher prevalence of hearing loss occurred in the workers with hypertension [35]. A study documented that there was a significant raise of blood pressure level in the workers who were exposed to occupational noise [36]. The same result was observed in a study conducted in Taiwan, where stated a positive correlation was observed between the noise level and blood pressure level [37]. In this study, the risk of hearing loss was 3 times higher among the workers with hypertension than among those who did not have hypertension, which was consistent with the findings of these previous studies.

Exposure to extremely loud noise for one time or exposure to loud noise for an extended period can cause hearing loss. Long periods of continuous noise exposure induce progressive and irreversible hearing loss in both ears [38]. The rate of hearing loss was particularly higher among workers with long duration of work experience in the industries. In this study, the workers with more than 9 years of service in the textile mill were 6 times more likely to have hearing loss than those with 9 years and less service duration.

Table 3
Factors associated with hearing loss among textile workers

Variables	Hearing loss n (%)		Bivariate analysis		Multivariate analysis [†]	
	Absent	Present	p value	COR (95% CI)	p value	AOR (95% CI)
Demographic factors						
Gender						
Male	9 (60.0)	6 (40.0)		1.00		
Female	159 (75.4)	52 (24.6)	0.20	0.49 (0.17-1.44)		
Age						
<35 years	118 (89.4)	14 (10.6)		1.00		1.00
≥35 years	50 (53.2)	44 (46.8)	0.001	7.42 (3.73-14.73)	0.001	6.90 (3.45-13.82)
Educational level [†]						
≥ High school education level	132 (78.6)	36 (21.4)		1.00		
< High school education level	36 (62.1)	22 (37.9)	0.01	2.24 (1.18-4.27)		
Current weaving sections						
Water jet loom	55 (73.3)	20 (26.7)		1.00		
Towel loom	54 (72.0)	21 (28.0)	0.86	1.07 (0.52-2.19)		
Bed sheet loom	59 (77.6)	17 (22.4)	0.54	0.79 (0.38-1.67)		
Risk behaviors						
Smoking						
No	163 (75.1)	54 (24.9)		1.00		
Yes	5 (55.6)	4 (44.4)	0.20	2.42 (0.63-9.32)		
Alcohol drinking						
No	167 (74.9)	56 (25.1)		1.00		
Yes	1 (33.3)	2 (66.7)	0.15	5.96 (0.53-67.04)		
Loud music listening						
No	138 (73.0)	51 (27.0)		1.00		
Yes	30 (81.1)	7 (18.9)	0.31	0.63 (0.26-1.53)		
Health problems						
Hearing difficulty						
No	162 (77.1)	48 (22.9)		1.00		
Yes	6 (37.5)	10 (62.5)	0.001	5.63 (1.95-16.27)		
Tinnitus						
No	156 (77.6)	45 (22.4)		1.00		1.00
Yes	12 (48.0)	13 (52.0)	0.01	3.76 (1.60-8.80)	0.03	2.88 (1.13-7.37)
Headache						
No	155 (74.5)	53 (25.5)		1.00		
Yes	13 (72.2)	5 (27.8)	0.83	1.13 (0.38-3.30)		
Earache						
No	160 (75.1)	53 (24.9)		1.00		
Yes	8 (61.5)	5 (38.5)	0.28	1.89 (0.59-6.02)		
Hypertension						
No	147 (79.9)	37 (20.1)		1.00		
Yes	21 (50.0)	21 (50.0)	0.001	3.97 (1.97-8.03)		
Diabetes mellitus						
No	166 (75.1)	55 (24.9)		1.00		
Yes	2 (40.0)	3 (60.0)	0.10	4.53 (0.74-27.80)		
Factors related with noise exposure						
Duration of service in textile mill						
≤9 years	103 (89.6)	12 (10.4)		1.00		
>9 years	65 (58.6)	46 (41.4)	0.001	6.07 (2.99-12.32)		
Duration of service in current section						
≤9 years	120 (77.9)	34 (22.1)		1.00		
>9 years	48 (66.7)	24 (33.3)	0.07	1.77 (0.95-3.28)		
Noise exposure level						
<85 dB(A)	59 (77.6)	17 (22.4)		1.00		
≥85 dB(A)	109 (72.7)	41 (27.3)	0.42	1.31 (0.68-2.49)		

AOR, adjusted odds ratio; COR, crude odds ratio; CI, confidence interval.

* Only significant variables after bivariate analysis (age, education level, hearing difficulty, tinnitus, hypertension, and service duration in factory) were included in the multivariate regression model.

† Education level – categorized as ≥ High school education level (high school education and graduate and above) and < High school education level (read and write, primary school education, and middle school education).

This finding was consistent with other studies conducted in Thailand [17], Ethiopia [25], Bangladesh [29], and Jordan [31], where long duration of employment predisposed to hearing loss among workers.

The NIOSH restricted the 85 dB(A) and more noise exposure level to protect hearing loss. It was expected that the workers who were exposed to 85 dB(A) and more noise exposure levels were at greater risk of developing hearing loss than those who were exposed to less than 85 dB(A). The studies conducted in Thailand [17], Ethiopia [25], and Jordan [31] stated that noise exposure level

was associated with a significantly higher prevalence of hearing loss. However, there was no significant association between noise exposure level and hearing loss in this study.

The other factors influencing PPD usage were not included in this study, and further qualitative studies might reveal hidden reasons for weakness of using PPDs in the workplace. Results of this study might be generalized to elsewhere in which the workers are employed in same occupational setting. However, if the implementation of occupational safety and health regulations is different (even in other occupational settings located in different regions/

states), the study results might be varied, particularly among those with diversity of demographic factors, risk behaviors, health problems, and consciousness on NIHL.

In conclusion, a hearing conservation program should be immediately implemented for effective prevention and control of hearing loss when the workers are exposed to 85 dB(A) and more. Installing quieter equipment in work process, enforcing usage of PPDs in workplaces, and applying work practices are the critical elements for noise control. In addition, the local national authority should focus on noise monitoring, engineering modifications of buildings and machinery, occupational safety policies, administrative controls, providing education on NIHL, periodic audiometric assessments, and follow-up evaluation for hearing threshold shift. This study supported the elements for further research studies related to the employer compliance with occupational health and safety regulations to address awareness of their responsibility in minimizing hazards in workplaces.

Ethics approval and consent

The ethical clearance was obtained from Ethical Committee, Defence Services Medical Academy, Yangon Region, Myanmar. The permission to collect the data was approved by authorities of Textile Mill (Thamine), Yangon Region, Myanmar. The study objectives, contents of questionnaires, measurement procedure and rights of participants were explained to the participants before obtaining permission and conducting interviews. The survey information sheets including study objectives, contents of questionnaires and rights of participants were explained by interviewers. Informed consents were obtained from all participants.

Author contributions

A.K.Z., Y.M.H., K.M.T., and Z.M.H. conceptualized and designed the study. A.M.M. and M.T.D. assisted in conceptualization and design the study. A.K.Z., Y.M.H., and T.H.A. collected the primary data. A.K.Z., Y.M.H., and K.M.T. carried out the statistical analyses. All authors participated in interpretation of the results. A.K.Z. and Y.M.H. developed the initial manuscript. All authors critically reviewed and revised the manuscript for important intellectual content and approved the final manuscript to be published.

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Conflicts of interest

All authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.shaw.2020.04.002>.

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