ORIGINAL ARTICLE

Noise Exposure and Perceived Hearing Symptoms of Metal Fabrication Workers in Heating, Ventilating and Air Conditioning Manufacturing Industry

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ABSTRACT

Introduction: Rapid ongoing industrialisation particularly in developing countries has triggered an increased risk of occupational noise-related disease occurrence. Machinery and work tasks in metal fabrication processes may produce high noise levels that can be harmful to hearing. This study aimed to investigate the workers' exposure to noise at a fabrication plant and their perceptions toward hearing loss symptoms and its association. **Methods:** This study was conducted at a Heating, Ventilating and Air Conditioning fabrication plant in Johor. With a 31% response rate, 50 respondents who were selected using purposive sampling answered a questionnaire regarding demographic background, noise exposure and perceived hearing loss symptoms. Noise measurements were also conducted among 30 of them based on the concept of sampling the maximum risky workers. The noise was measured using a sound level meter IEC 60651 Class 2. Minimum (L_{min}) and maximum (L_{max}) sound pressure levels were measured for 5-minute and repeated for three exposure periods (morning, afternoon, evening). **Results:** 68% and 32% of the workers were 20-30 years old and had been employed for 3-5 years, respectively. Average noise exposure level observed was 63.3-101.5 dBA. 25% of the workers reported that they were sometimes experienced the symptoms of hearing loss. These include difficulty in understanding conversation and ringing in the ear. However, noise exposure and hearing loss symptoms were not significantly associated. **Conclusion:** The study findings suggest that the workers have a risk of developing hearing loss. Intervention programme and enforcement on hearing protection of the workforce are highly recommended.

Keywords: Noise exposure, Maximum noise level, Hearing loss symptoms, Hearing impairment, Metal fabrication

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INTRODUCTION

Excessive noise exposure can cause hearing loss. The occurrence of work-related hearing impairment remains a concern in developing and industrialised countries due to high noise emission either from machinery, work processes, job tasks or combination of these if not properly controlled. The type of industry and occupation were found to be associated with noise-induced hearing loss (NIHL) in previous studies (1-3). The findings also found that metal manufacturing industries, agriculture, mining and construction industries had a high prevalence of hearing impairment (4,5). Significant hearing loss was observed in more than 90% of the workers in the steel industry where the typical noise levels are between 80 and 125 dBA (6). Type of occupation is suggested as a crucial factor that determines the noise level (7-9). Studies in the United States reported that nearly half of the carpenters (44%) and plumbers (48%) experienced perceived hearing loss. Approximately, 70% of male workers could get hearing impairment at 60 years old in either metal or non-metal mining industries (10). Although the implementation of engineering control, safe work procedures and maintenance of personal protective equipment were done, there are some other factors can affect the noise exposure level. These include work process and operation, raw materials and equipment used (11).

In Malaysia, the main occupations which are at risk of developing NIHL are military workers, policemen, factory workers, construction workers, heavy industry workers, carpenters, lorry drivers, musicians, grass cutters and air traffic controllers (12). The number of workers exposed to occupational noise in metal (2,091), textile (631) and food industries (439) was the highest compared to other industries. 28% of these industries

reported noise exposure level at 91-140 dBA and 72% with 86-90 dBA (13). The tools and tasks in industries including a hand drill, chop saw, metal shear, impact wrench, belt sander and router normally recorded noise level above 85 dBA (14). The typical noise level in metal fabrication work is 80-125 dBA. The sources of noise that are commonly found in this work process include angle grinders, metal presses, cutting saws and hammering and bashing on metal objects. Other sources may come from welding and gouging. Although noise from these sources are generally produced in short duration, the noise level can be very high (15). Further, the workers may be engaged with this type of exposure repeatedly during each shift and consequently affect their hearing as impact or impulsive noise can be more harmful than steady-state noise (16).

Permanent hearing loss is primarily found among industrial workers who are continuously exposed to high-intensity noise in the long term of employment (17). World Health Organisation reported that exposure to occupational noise has caused deafness (16%). 22% of the cases occurred among male workers and 11% among females. Majority of them are aged 15-59 years (89%). In total, NIHL has been reported in more than four million individuals (18). A person with hearing loss might experience ringing, pressure or bleeding in the ear (19), difficulties in understanding a conversation such as often missing or confuse certain words, delays in speech and language development, attention and behavioural difficulties (20), speaking too loudly (21), and watching television with high volume (22).

In developing countries, NIHL cases are more constantly occurring than in developed countries (23). In 2017, 64% (2,478) of 3,890 occupational disease and poisoning cases reported in Malaysia were occupational noise-induced hearing disorders including NIHL, hearing impairment and permanent standard threshold shift (24). In Malaysia, high NIHL cases have been reported in selected manufacturing industries at Johor, Pahang, Pulau Pinang, Selangor and Terengganu in 2011 (13). In the workplace settings of this study, the occupational noise exposure levels have not been adequately identified and characterised. It is essential to conduct an assessment at the workplace to minimise the exposure to occupational noise (25), and this is also required under Regulation 3 and 4 of the Occupational Safety and Health (Noise Exposure) Regulations 2019. Furthermore, workers at this fabrication plant have complained about their hearing problems but no immediate action has been taken so far for further diagnosis, treatment and control of this issue. Worker's complaints must always be considered for the need for exposure measurement (26). Therefore, this study aimed to assess the noise levels at the fabrication plant and worker's perception of symptoms of hearing loss and to explore the association between the exposure and symptoms. The study findings could provide information and guidance, as well as an initiator to the Health, Safety and Environment department and top management to implement new or revised procedures and guidelines at the workplace as to reduce the risk of noise exposure and maintain a safe working environment for the workers. Additionally, the reported hearing loss symptoms from this study could indicate the need for audiometric testing of the workers.

MATERIALS AND METHODS

Sampling site and population

This study was conducted in 2014 at the fabrication plant in a heating, ventilating, and air conditioning manufacturing industry located in Johor using a cross-sectional design. A site survey was conducted with a supervisor to identify workers with the greatest exposure to noise. The work tasks and duration for each activity were noted. Prior notice on the date and time of the noise monitoring was given to the workers to ensure that they operate the equipment and perform their tasks under the normal condition when the measurement is undertaken.

The operation hour of the plant was between 8:30 a.m. and 5:30 p.m., and sometimes until 10:00 p.m. if there were necessary extra works to be done. Mainly, every worker in the plant were exposed to identical sources of noise, thus they had similar exposure. The main source of the noise was from metalworking processes using machines and tools. Based on the evaluation from the site survey, noise measurements were conducted at 22 sampling points which are piping (3), air compressor and cooling unit (3), air handling unit (3), ducting and damper (3), computer numerical control (3), factory acceptance test area (4), etching (1), and store (1) as exposed area and office (1) as a control area.

Noise measurements

Noise were measured using Blue Gizmo Sound Level Meter (SLM) BG 325 and TES-1351B SLM which met the standards IEC 60651 Class 2 and ANSI S1.4 Class 2. Noise measurements were taken three times a day within the shift working hours which are in the morning, afternoon and evening. For each sampling sessions, the minimum (L_{min}) and maximum (L_{max}) sound pressure levels were recorded for five minutes. SLM was held at arm's length within 0.2 meters of the worker's ear canal entrance and perpendicular to the noise sources (27). This sampling involved 30 workers who worked in the areas with the greatest noise exposure. The time, location, specific activity of the worker and door opening condition were also recorded during the measurement.

The noise levels recorded at each sampling sessions were then averaged using the following equation: $Lp=10\log^{10}[(1/n)(10^{x}+10^{y}+10^{z})]$, where Lp=average decibel level, n=number of decibel level, and x,y,z=decibel level (28) to estimate daily noise exposure

levels for each task and specific area measured. The noise levels were then categorised into three groups of exposure: minimum noise exposure for noise level lower than 85 dBA, moderately high exposure for 85-90 dBA and high exposure for more than 90 dBA (29).

Questionnaire

The minimum number of respondents required for this study was 44. Therefore, a questionnaire was distributed to 50 workers (31% response rate) to identify the hearing symptoms from noise exposure. The respondents were selected using purposive sampling based on the inclusion and exclusion criteria. Only those who worked in the fabrication area and exposed to noise during working hours were included in this study. Administration workers were not included in this study as they were considered to have low exposure to noise. Workers who were more than 50 years old were excluded from this study as people at this age are more likely to get hearing loss (5).

The questionnaire was adapted and modified from previous studies (30,31,44). The questionnaire consisted of 19 questions with open-ended and Likert-scale formats which divided into three sections; Section A-demographic and employment background, Section B-noise exposure and Section C-hearing loss symptoms. In Section B, the workers were asked whether they are frequently exposed to noise at and outside work and used hearing protection while working. Whereas in Section C, the workers were asked whether they are frequently experienced difficulties in understanding conversation, buzzing in ears, talking too loud, watching television in high volume and seek treatment for a hearing problem.

A pilot study was conducted among 10 workers from the same plant to validate the questionnaire. However, the results from pilot study were not included in the actual analysis. The Cronbach alpha obtained was 0.801, thus indicated that the questionnaire was reliable. Permission from the company and approval from the Human Research Ethics Committee of Universiti Sains Malaysia (USM/JEPeM/275.4(1.4)) were obtained before conducting this study.

Data analyses

Data analyses were done using Statistical Package for Social Science (SPSS) version 20.0. Noise exposure levels were presented in mean and standard deviation and demographic distributions, perception on noise exposure and hearing symptoms were presented in frequency and percentage. Differences of noise exposure levels and the presence of hearing symptoms were analysed using the Mann-Whitney test. Association between noise exposure from non-occupational activities and hearing symptoms were explored using Chi-square and Fisher's Exact tests.

RESULTS

Sociodemographic and employment characteristics

Over 80% of the workers were Malay. Only male workers involved in fabrication activities for the whole factory. Majority of female workers were working in the office. As shown in Table I, the majority of the respondents (68%) were young workers with age between 20-30 years old. All respondents have formal education with 18% had secondary education and university qualification of each. 32% of the respondents had worked for 3-5 years in the company and 18% had served for 1-3 years. Majority of the respondents (92%) had no chronic disease while 8% had diseases like hypertension and diabetes. 72% of the workers were exposed to loud noise at a previous job.

Table I : Distribution of the respondents by demographic and employment characteristics (n=50)

Characteristics	Frequency (n)	Percentage (%)
Age (years)		
20-30	34	68
31-40	11	22
41-50	5	10
Education level		
Secondary Education	9	18
Certificate	32	64
University (Diploma/Degree/Master)	9	18
Duration of Employment (years)		
Below 1	15	30
1-3	9	18
3-5	16	32
More than 5	10	20
Chronic disease		
Yes	4	8
No	46	92
Exposed to noise at previous job		
Yes	36	72
No	14	28

Noise levels for specific job tasks

At this fabrication plant, there were various work tasks carried out by the workers. Based on the site survey, at least one person was doing three different work tasks and can be up to 5-7 work tasks. This was instructed by the supervisor and also depending on the work demand. The types of noise observed were continuous, fluctuate and impulsive. Example of the common work tasks that produced impulsive noise was metal shearing and fitting. Some of the work activities that required a competent person included driving a forklift, welding and controlling laser cutting operation. Table II shows the average L_{min} and L_{max} of each

work tasks. The highest noise levels recorded were from forklift (74.3-102.5 dBA), followed by fitting (71.3-98.3 dBA) and shearing (70.0-96.5 dBA). The lowest noise levels were observed from etching and rolling activities with 65.4-88.5 dBA and 66.5-88.8 dBA, respectively.

Table II : Minimum (L_{min}) and maximum (L_{max}) noise levels for specific job tasks

Work Tasks	L_{min} (dBA)	L_{max} (dBA)
Driving forklift	74.3	102.5
Fitting	71.3	98.3
Shearing	70.0	96.5
Grinding	70.1	95.4
Handling overhead crane	73.0	94.6
Drilling	73.0	94.4
Computer numerical control operation	72.2	94.3
Handling plate	69.3	94.3
Cutting	71.9	93.6
Welding	75.3	92.1
Preparation for leak test	70.0	92.2
Bending	73.0	91.9
Wrapping	67.0	91.1
Packing	69.3	91.8
Store keeping	73.0	90.1
Data entry	67.0	89.8
Brazing	69.3	89.0
Applying acid	66.4	89.0
Etching	65.4	88.5
Rolling	66.5	88.8

Noise exposure

Table III shows the L_{min} and L_{max} of each work areas based on the measured noise exposure level. Of the 30 respondents, 4 workers were exposed to 96-100 dBA L_{max} and 2 workers were exposed to more than 100 dBA L_{max}. On the whole, all workers were categorised under minimum exposure group (<85 dBA) for L_{min}. However, for L_{max}, all workers were categorised under high exposure group (>90 dBA).

Perception on noise exposure and safe practice

More than 50% and 42% of the workers were always and often exposed to loud noise, respectively. 30% of the workers often used hearing protection such as earplug and ear muff, whereas 6% of the workers never used the hearing protection devices. Additionally, 10% of the workers were exposed to noise from activities other than working hours such as leisure and hobbies (Table IV).

Perceived hearing symptoms

42% of the workers have sometimes experienced difficulties in understanding daily conversation and 30% of them experienced buzzing or ringing in the ear. More than 50% of the workers rarely asked other people to repeat the word during communication and only 8% of them often complain by other people that they were talking too loud. Occasionally, 26% of the workers turning the television's volume too high. 68% of the workers never see a doctor examine their ears. Besides, 6% of the workers claimed that they had hearing difficulty (Table V).

Table III : Minimum (L_{min}) and maximum (L_{max}) noise levels at the work area of the risky workers

Worker	L_{min} (dBA)	L_{max} (dBA)
1	71.3	101.9
2	71.3	101.2
3	70.1	96.9
4	72.2	96.8
5	75.3	96.8
6	71.9	96.1
7	73.0	95.0
8	70.0	95.0
9	73.0	95.7
10	67.0	95.2
11	69.3	95.3
12	69.3	95.3
13	70.9	94.2
14	70.0	94.6
15	70.0	94.2
16	69.5	94.1
17	72.2	94.3
18	67.7	94.2
19	70.5	94.1
20	63.3	94.0
21	71.3	93.9
22	63.3	93.1
23	69.9	93.4
24	69.9	93.3
25	68.6	93.0
26	72.3	92.8
27	70.0	92.8
28	70.9	92.4
29	70.6	92.1
30	69.7	92.2
Mean±SD (n=30)	72.0±2.5	96.0±2.3

SD: Standard deviation

Table IV : Perception of the respondents on noise exposure and safe practice (n=50)

Noise exposure	Frequency (%)				
	Never	Rarely	Sometimes	Often	Always
Exposed to loud noise at current job	0(0)	0(0)	0(0)	21(42)	29(58)
Use of PPE	3(6)	9(18)	14(28)	15(30)	9(18)
Non-occupational noise activities	19(38)	14(28)	12(24)	5(10)	0(0)

PPE: Personal protective equipment

Table V : Perceived hearing loss symptoms of the respondents (n=50)

Symptoms	Frequency (%)				
	Never	Rarely	Sometimes	Often	Always
Difficult to understand conversation	13(26)	16(32)	21(42)	0(0)	0(0)
Buzzing or ringing in the ear	7(14)	28(56)	15(30)	0(0)	0(0)
Ask others to repeat conversation	3(6)	27(54)	12(24)	7(14)	1(2)
High TV volume	22(44)	13(26)	15(30)	0(0)	0(0)
Talk too loud	21(42)	15(30)	10(20)	4(8)	0(0)
Hearing check-up	34(68)	10(20)	6(12)	0(0)	0(0)
Perceived hearing ability	**Very good**	**Good**	**Not sure**	**Little trouble**	**Lot of trouble**
Hearing ability without the use of hearing aid	10(20)	26(52)	11(22)	3(6)	0(0)

Table VI : Differences between exposure to minimum (L_{min}) and maximum (L_{max}) noise levels with presence of hearing loss symptoms (n=30)

Symptoms of hearing loss		Median (IQR) L_{min}	p-value	Median (IQR) L_{max}	p-value
Difficult to understand conversation	Yes	70.0(2.2)	0.907	94.2(1.4)	0.086
	No	69.0(2.8)		92.2(3.1)	
Ask others to repeat conversation	Yes	70.1(1.9)	0.157	94.2(2.2)	0.114
	No	69.0(0.0)		92.6(0.0)	
High TV volume	Yes	70.0(1.8)	0.967	94.0(2.3)	0.371
	No	10.0(3.5)		94.4(2.4)	
Talk too loud	Yes	70.0(1.9)	0.734	94.2(2.2)	0.767
	No	70.3(3.3)		94.4(3.1)	
Hearing check-up	Yes	70.5(1.6)	0.596	94.0(2.8)	0.458
	No	70.0(2.8)		94.1(2.0)	

Significant difference at p<0.05; Statistical test-Mann Whitney test : IQR: Interquartile range

Table VII : Association between non-occupational noise exposure and symptoms of hearing loss (n=50)

Symptoms of hearing loss		Non-occupational noise exposure, n (%)		p-value
		Yes	No	
Difficult to understand conversation	Yes	21(67.7)	16(84.2)	0.320[b]
	No	10(32.3)	3(15.8)	
Buzzing or ringing in the ear	Yes	27(87.1)	16(84.2)	1.000[b]
	No	4(12.9)	3(15.8)	
Ask others to repeat conversation	Yes	31(100.0)	16(84.2)	0.049[b]
	No	0(0.0)	3(15.8)	
High TV volume	Yes	16(51.6)	12(63.2)	0.559[b]
	No	15(48.4)	7(36.8)	
Talk too loud	Yes	16(51.6)	13(11.0)	0.376[b]
	No	15(48.4)	6(31.6)	
Hearing check-up	Yes	9(29.0)	7(36.8)	0.756[b]
	No	22(71.0)	12(63.2)	
Hearing ability	Good	1(3.2)	2(10.5)	0.058[a]
	Not Sure	4(12.9)	7(36.8)	
	Poor	26(83.9)	10(52.6)	

Significant difference at p<0.05; Statistical test: [a]Chi-Square test, [b]Fisher's Exact test

Noise exposure and hearing loss symptoms

No significant differences were found between exposure to L_{min} and L_{max} with the presence of hearing loss symptoms (Table VI). Median L_{min} and L_{max} among the workers who have or did not have symptoms of hearing loss were similar. Amongst respondents who are involved in non-occupational activities, no significant associations were found between noise exposure from these activities and all hearing loss symptoms except for requiring others to repeat the conversation. However, only borderline significant association (p=0.049) was found for this symptom (Table VII).

DISCUSSION

Noise exposure and associated factors of hearing loss symptoms

Exposure to occupational noise in metalworking industries is unavoidable. In the fabrication plant, the noise levels were ranged between 63.3 and 101.5 dBA. These results were consistent with previous study findings (32) in which the noise was ranged between 66 and 97 dBA. The study also claimed that the workplace with this range of noise level cause workers to shout when communicating with each other. In this study, driving forklift, fitting, shearing and grinding activities recorded the highest noise levels. The fitting activities produce a high level of noise when the hard and reflected surface contacted with other metal. Whereas for shearing activities, loud noise was emitted when the small size stainless steel contacted with the ground floor. A study had found that the noise comes from grinding also caused hearing problems (33). Exposure to this excessive noise may gradually cause hearing impairment.

Majority of the respondents in this study were in the age group of 20-30 years old that are prone to develop NIHL as suggested in the previous study (34). Additionally, longer employment period will increase the likelihood to develop NIHL and hearing impairment with relation to age and duration of exposure. The occurrence of NIHL is increasing from 6 to 20 years of employment (35). Most respondents have worked for less than 5 years in this fabrication plant. Many of them were new workers because of the high number of turn over. However, the majority of the workers have been exposed to noise from the previous job at various type of industries such as shipping, manufacturing, fabrication and heavy engineering. Average noise levels reported in heavy engineering industries were range between 83 and 116 dBA while manufacturing industries can be up to 115 dBA (36). Young workers who have had previous occupational noise exposure were exposed to greater rates of hearing loss (37,38). Thus, this previous exposure may also contribute to the risk of hearing loss. Most of the respondents did not engage in any noisy activities out of working hours. The workers claimed that they had no hobby or specific activities associated with noise. Only a few workers had activities related to noise such as sports, music and workshop activities. Majority of the respondents had difficulties in understanding everyday conversation. Workers who had an average changed of 10 dB for their hearing threshold experienced communication difficulties (32). Workers at this plant need to raise their voice to communicate at a distance of one meter. Moreover, only a few respondents did not experience buzzing or ringing in the ear. Most of the workers asked others to repeat their words when they interact. These are the common signs of hearing loss. These reported symptoms could be explained by the poor practice of the workers since half of them did not properly use their hearing protection while working (39). Based on the information obtained from the site supervisor, the organisation have not been fully implemented the hearing conservation program even though some of the work areas have excessive noise levels. This has put the workers at more risk of developing hearing loss particularly those who work with machinery for more than 8-hour shift per day.

Association of noise and hearing loss symptoms

No significant differences have been found between noise levels and presence of hearing symptoms even though the daily and weekly noise exposures were more than eight and seventy hours, respectively. This might be due to the factors of inaccurate personal noise monitoring technique as the noise should be measured for working hours using dosimeter. However, the possibility of developing hearing loss cannot be neglected as the level of noise exposure were continuously high. In the previous study, higher risk of hearing loss was found among workers with a shift over eight hours a day (32). Besides, the intensity of noise and period of exposure at the workplace determined the risk of hearing loss (40). A study in Turkey suggested that long working period will tend to exceed the maximum exposure limit (90 dBA) as set by the Occupational Safety and Health Administration (41). Initial temporary hearing damage can become permanent due to constant exceedance of the noise permissible limit (8). Continuous noise exposure may affect the communication and lead to social isolation with families, friends and co-workers.

Majority of the workers in this study rarely experienced the symptoms of hearing loss. This contradicting finding with previous studies might be due to small sample size and many workers might probably unaware of losing their hearing ability because the hearing loss has a gradual onset (42). This occurs when the workers admitted that the noise and their job could not be separated and they became less sensitive to the noise

as their hearing threshold has increased (6). Moreover, low noise sensitivities cause the majority of the study population to prefer not to report any noise-related issues and work-related disease to secure their job (43). Additionally, using a questionnaire for NIHL screening is inadequate (44). Pure-tone audiometric testing is instead a better tool for identifying the presence and severity of hearing loss (5).

In this study, workers who had exposed to noise from non-occupational activities were prone to ask others to repeat their words when communicating. People with hearing loss symptoms heard vowel sound better than consonant sound. Unclear of consonant sound can distort both speaking and hearing (21). Outside work, although people are exposed to high noise levels during their leisure activities, they will rarely use any hearing protection. Thus, there are high possibilities to get hearing loss especially if they are frequently engaged with non-occupational noise (45).

Study limitations

The noise assessment in this study was done only at one plant due to limitation on permission and access to other plant and related industries. Unavailability of a suitable noise instrument (noise dosimeter or integrated sound level meter) to conduct personal noise exposure monitoring was another limitation in this study, hence continuous exposure measurement could not be done. Although the noise assessment was done based on area monitoring, however, the measurements were taken near to the hearing zone of the workers, thus the results can also indicate the noise exposure level of the worker. Further, even though the noise were measured in a short period, but the measurements were done repeatedly for three exposure periods which then each reading were averaged to estimate daily noise exposure levels. The noise metrics used in this study were L_{min} and L_{max} instead of the equivalent continuous sound pressure level (L_{Aeq}) due to limited functions of the available noise instrument, hence the results from this study cannot be compared with the standard recommendation limit. Nonetheless, the results were representable to indicate the workplace noise levels as the work process in this type of industry mainly produced intermittent and impulsive noise.

Initially, the questionnaire was planned to be distributed during Monday assembly, but there were limitations in term of time and number of workers attending this session. A researcher-administered survey was then used to complete the questionnaire. Although this approach could introduce interviewer bias, however higher response rate can be obtained, questions can be clarified and completion of the questionnaire can be ensured. Besides, the assessment of hearing symptoms was solely based on self-reported symptoms through the questionnaire given for which it should be supported by audiometric testing. Yet, due to limited resources and time, such assessment could not be done. However, this study able to conduct a preliminary assessment of noise at the plant by identifying the area of concern and evaluate the risk of hearing loss among the exposed workers. These findings are valuable for the management and also workers to take preventive and control measures in reducing the risk.

CONCLUSION

The findings from noise assessment at fabrication plant demonstrated that the noise exposure levels were between 63.3 and 101.5 dBA, with the highest noise emissions from driving forklift, fitting and shearing. Frequent exposures to loud noise were observed among all workers and this was consistent with the L_{max} obtained for each worker as all of them were categorised in the high exposure group (>90 dBA). About a quarter of workers reported that they were sometimes experienced the hearing loss symptoms. This might indicate the risk of developing NIHL since the noise exposures were constantly high for the three measurement period. However, the associations between noise exposure and perceived hearing symptoms could not be found. Overall, it is recommended that the management and employees take initiatives to reduce the noise levels emitted from the work settings and develop hearing conservation programme (HCP) as to provide a conducive working environment and ensure workers' safety, health and welfare. The HCP should include and not limited to noise exposure assessments, audiometric testing, engineering control, education and training, proper use of hearing protection, and programme evaluation as to reduce occupational noise-related disease effectively.

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