Original Article

Noise Exposure and Hearing Symptoms Among Laundry Workers and Mechanical Cutters in a Teaching Hospital

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ABSTRACT: *Workers who are exposed to high noise level were at risk of noise-induced hearing loss (NIHL). This cross-sectional study was conducted to investigate the noise exposure level and hearing symptoms among workers exposed to noise in a teaching hospital. Utilising convenience sampling method, 20 laundry workers and 17 mechanical cutters were recruited into this study. Noise exposure levels were measured using noise dosimeter for 8 hours and information on hearing symptoms were gathered using a modified questionnaire adopted from the American Speech Language Hearing Association (ASHA). A significantly higher mean noise level (85±2 dB(A)) was reported among mechanical cutters as compared to laundry workers (80±3 dB(A)), p=0.001 although the former had shorter duration of noise exposure (20±3 hours per week vs. 28±12 hours per week). Fourteen (70%) laundry workers and six (35%) mechanical cutters had reported having hearing problem in noisy background. Higher proportion of laundry workers (n=8, 57%) had reported hearing symptoms compared to mechanical cutters (n=6, 43%) and longer work years was found to be significantly associated with hearing symptoms (p=0.049). There is a need of appropriate education and training on noise exposure, NIHL and hearing protection devices usage in the workplaces.*

Keywords - *Hearing Symptoms, Laundry Workers, Mechanical Cutters, Noise Exposure*

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1.0 INTRODUCTION

Noise-induced hearing loss (NIHL) is a public health concern and considered as the major preventable cause of hearing loss in the workplace (Basner et al., 2014). Workers engaged in heavy industries, factories, forge hammering, coal and ore mining, construction, cement plants, gas processing industries and mechanical engineering, mill and stationary machine device operators and workers at oil refineries are at risk of occupational NIHL (Azizi, 2010). In Malaysia, occupational noise-induced hearing disorders (which include NIHL, hearing impairment and Permanent Standard Threshold Shift) was the highest reported occupational disease compared to other diseases in the year 2016 with 2876 cases (74.5%) (DOSH, 2017).

Many factors have been suggested contributing to the NIHL such as age, smoking, gender, race, individual susceptibility, sound pressure level or noise intensity, the duration of noise, daily exposure period, total exposure period, existence of ear disease, working conditions, distance to noise source, direction of sound waves and the position of the ears and poor usage of hearing protection devices (Cruickshanks et al., 2003). The Malaysia Factories and Machinery (Noise Exposure) Regulation 1989 was introduced to protect the workers from excessive exposure to noise (FMA, 2015). Under this regulation, workers are protected from excessive noise exposure to reduce the risk of NIHL. The Act stated that employees shall not be exposed to noise level exceeding equivalent continuous A-weighted sound pressure level of 90 dB(A) nor to noise level exceeding 115 dB(A) at any time. Excessive exposure to the permissible limit should be prevented and the noise reduction plan must be initiated.

In this study, the potentially high risk noise-exposed groups of hospital workers identified were among workers at the laundry unit and mechanical department. The use of heavy machineries in the laundry unit such as washer and dryer machines may produce harmful noise level. Mechanical department workers in the hospital are involved with mechanical machines that

produce high noise level which were used for maintenance activities such as grass, wood and metal cutting. It was believed that continuous exposure to high levels of sound pressure may bring about permanent changes in the workers' hearing threshold (Fontoura et al., 2014). Thus, in this current research, reported hearing loss symptoms related to noise exposure at workplace among laundry workers and mechanical cutters were studied. This study finding could be used to increase awareness to both parties and may lead to suggestions or appropriate intervention for preventing NIHL among workers at the studied workplaces.

2.0 METHOD

2.1 Study Design

This cross sectional study was conducted using convenience sampling method recruiting 20 laundry workers and 17 mechanical cutters such as grass, metal and wood cutters at a teaching hospital in measuring their noise exposure level and associated hearing symptoms. The study was approved by the Campus Director and Human Research Ethics Committee (reference: USM/JEPeM/16110504). All study participants were provided with research information and voluntarily signed the research and publication consent forms before data collection.

2.2 Questionnaire

All participants were requested to complete a self-administered questionnaire and work activity diary. The questionnaire comprised of four parts that include socio-demographic information (part A), medical history (part B), workplace noise exposure (part C) and hearing symptoms (part D). Part D was adapted and modified from the American Speech Language Hearing Association (ASHA) (ASHA, 2016). To ensure the validity and suitability of the questionnaires, it was piloted among 10% of the intended total population (among six supporting staff) that were not included in this study. Cronbach's alpha analysis was conducted to test the reliability of the questionnaire. The result obtained was 0.843 which was considered good and reliable as the acceptable value of alpha is between 0.70 to 0.95 (Tavakol & Dennick, 2011).

2.3 Walk through Survey and Personal Noise Monitoring

A walk through survey was conducted to identify the high noise level areas and job tasks at different job sections. The workers who agreed to participate in this study were requested to wear a personal noise dosimeter (Model: Spark 703, Larson Davis, Sweden) with the microphone clipped on to the collar of the worker near the hearing zone. Determination of the noise exposure level was accomplished using calibrated noise dosimeter for eight hours during working day. Pre-calibration and post-calibration of the dosimeter was performed following the manufacturer's instruction. The workers were ensured that they were comfortable wearing the device without disturbing their work routines.

2.4 Data Analysis

Blaze software (Larson Davis, Sweden) was used to analyse the noise exposure level data and the IBM SPSS software Version 22 was used to perform the statistical analyses. The statistical analysis with p value of less than 0.05 was set as significant. Normality was tested using the Shapiro-Wilk test and the result showed that data were normally distributed ($p>0.05$). Descriptive statistics were performed in presenting the sociodemographic characteristics and work descriptions of workers in frequencies, percentages, mean and standard deviation (SD). The independent t-test was performed to compare the mean noise exposure level between laundry workers and mechanical cutters. Meanwhile, Pearson Chi-Square test was utilised in establishing the association of hearing symptoms between the two groups.

3.0 RESULTS

3.1 Sociodemographic Characteristics and Work Description

The response rate of this study was 82% (N=37). All workers were Malaysian with an average (mean±standard deviation (SD)) age of 48±11 years old. Majority were males (81%, n=30) and more than half received education up to Sijil Pelajaran Malaysia (SPM) level (68%, n=25). Less than half (38%, n=14) of the workers reported a history of current smoking.

The laundry workers reported longer work employment duration (mean±SD) of 28±12 years compared to mechanical cutters, 20±3 years ($p=0.127$). When comparing the duration of noise exposure between laundry workers and mechanical cutters, the former had reported a significantly longer duration of noise exposure per week compared to the latter (28 hours per

week vs. 20 hours per week), p=0.009. Only five workers (14%); two laundry workers and three mechanical cutters were found to have used hearing protection devices (Table 1).

Table 1: Sociodemographic and Work Characteristics of Workers

Variables	Laundry workers (n=20)	Mechanical cutters (n=17)	Total (N=37)
Mean age, years ± SD	45±12	51±8	48±11
Gender, frequency (%)			
Male	13 (65)	17 (100)	30 (81)
Female	7 (35)	0 (0)	7 (19)
Education level, frequency (%)			
SRP/PMR	2 (10)	10 (59)	12 (32)
SPM	18 (90)	7 (41)	25 (68)
Smoking status, frequency (%)			
Yes	6 (30)	8 (47)	14 (38)
No	14 (70)	9 (53)	23 (62)
Mean working years ± SD	18±13	23±10	20±12
Duration of noise exposure, hours per week			
Mean ± SD	28±12	20±3	25±10
Min	10	15	10
Max	39	24	39
Use of HPD			
Yes	2 (10)	3 (18)	5 (14)
No	18 (90)	14 (82)	32 (86)

SD - standard deviation; SRP - Sijil Rendah Pelajaran; PMR - Penilaian Menengah Rendah; SPM - Sijil Pelajaran Malaysia; HPD - Hearing protection devices

3.2 Walk through Survey and Noise Exposure Levels

Table 2 describes the work tasks and their average noise levels for laundry workers and mechanical cutters. Generally, laundry workers worked in five sections which are sorting and folding (15%), washing and drying (25%), ironing and folding (35%), sewing (10%) and supplying (15%). However, it is noteworthy that the workers work by rotation system according to job demand. Almost all the mechanical cutters recruited in this study involved in grass cutting (88%, n=15). However, they were usually involved in grass cutting activity in the morning (8.30 a.m. to 12.30 noon) and in the afternoon (2.00 p.m. to 5.00 p.m.), and also performed other duties such as sweeping and collecting garbage.

Table 2: Work Task Description and Average Noise Level among Laundry Workers and Mechanical Cutters

Work Task	Frequency	Percentage	Mean noise level L_{Aeq} ± SD (dB(A))
Laundry workers (n=20)			
Sorting and folding	3	15	82±4
Washing and drying	5	25	82±2
Ironing and folding	7	35	81±2
Sewing	2	10	76±2
Supplying and folding	3	15	76±1
Mechanical cutters (n=17)			
Hand grass cutting	13	77	85±2
Tractor grass cutting	2	12	86±3
Wood cutting	1	6	87
Metal cutting	1	6	85

dB(A) - Decibel (A); SD - Standard Deviation

There was one worker each at the sorting and folding section and at the washing and drying section who had noise exposure level of more than 85 dB(A), but on average both sections reported 82 dB(A). The highest level of noise exposure was recorded for a hand grass cutter (90 dB(A)), but on average their overall exposure was 85±2 dB(A) (Table 2). Whereas Table 3 shows the mean noise level measurement among mechanical cutters were significantly higher (L_{Aeq} = 85±2 dB(A)) compared to laundry workers (L_{Aeq} = 80±3 dB(A)), p=0.001. The work groups' noise exposures were further categorised based on the action level, of which majority of laundry workers (90%, n=18) were exposed to noise for <85 dB(A), while majority of mechanical cutters were exposed to noise for ≥85 dB(A) (59%, n=10), p=0.002.

Table 3: Comparison of Mean Noise Exposure Level between Laundry Workers and Mechanical Cutters

Variable	Laundry workers (n=20)	Mechanical cutters (n=17)	*p*-value
Mean L_{Aeq} ± SD (dB(A))	80±3	85±2	**0.001*[a]**
Noise exposure category, n (%)			
<85 dB(A)	18 (90)	7 (41)	**0.002*[b]**
≥85 dB(A)	2 (10)	10 (59)	

dB(A) - Decibel (A); [a]*p*-values were based on Independent t test; [b] *p*-values were based on Pearson Chi-Square *p<0.05

3.3 Reported Hearing Symptoms

Table 4 shows the perception of workers towards hearing symptoms due to noise exposure. Only one symptom (trouble hearing in a noisy background) showed significant association as majority, 70% (n=14) of laundry workers had reported such symptom compared to only 35% (n=6) among mechanical cutters. Similarly, more laundry workers reported problem of hearing in noisy restaurants (55%, n=11), although the difference was non-significant.

Table 4: Reported Hearing Symptoms among Laundry Workers and Mechanical Cutters

Variables	Frequency (%)		*p*-value
	Laundry workers (n=20)	Mechanical cutters (n=17)	
Hearing problem over the telephone	2 (10)	1 (6)	1.000[a]
Hear better through one ear than the other when on the telephone	5 (25)	3 (18)	0.701[a]
Trouble following the conversation with two or more people talking at the same time	6 (30)	3 (18)	0.462[a]
Being complained that has turned the TV volume up too high	3 (15)	2 (12)	1.000[a]
Having to strain to understand conversation	5 (25)	6 (35)	0.495[b]
Trouble hearing in a noisy background	14 (70)	6 (35)	0.035[b*]
Trouble hearing in restaurants	11 (55)	6 (35)	0.231[b]
Having dizziness, pain or ringing in the ears	1 (5)	4 (24)	0.159[a]
Asking people to repeat themselves	3 (15)	0 (0)	0.234[a]
Family members or co-workers remark about missing what has been said	2 (10)	0 (0)	0.489[a]
Many people seem to mumble (or not speak clearly)	2 (10)	2 (12)	1.000[a]
Misunderstand what others are saying and respond inappropriately	4 (20)	1 (6)	0.348[a]
Trouble in understanding the speech of women and children	2 (10)	2 (12)	1.000[a]
Having people getting annoyed because of misunderstand what they say	2 (10)	1 (6)	1.000[a]

[a]*p*-values were based on Fisher's Exact test; [b]*p*-values were based on Pearson Chi-Square test; *p<0.05

3.4 Association between Work Factors and ASHA's Category of Hearing Symptoms

The American Speech Language Hearing Association (ASHA) recommended that when there is presence of more than two hearing symptoms, the particular person is suggested to be evaluated by a certified audiologist. Table 5 shows that a higher proportion of laundry workers (57%, n=8) needed further evaluation by a certified audiologist as compared to mechanical cutters (43%, n=6). Majority of the workers were exposed to noise level below 85 dB(A), 71% (n=10), compared to only four workers (29%) were exposed to noise exceeding 85 dB (A) and reported having more than two hearing symptoms. Hence, no significant association was found between noise exposure categories and hearing symptoms. However, only working years was found to be associated with hearing symptoms (p=0.049). Majority of the workers, 64% (n=9) reporting more than two

hearing symptoms had been working for 30 to 39 years. None of the sociodemographic characteristics were significantly associated with hearing symptoms based on ASHA's recommendation (results were not tabulated).

Table 5: Association between Work Factors and ASHA's Category of Hearing Symptoms

Characteristics	ASHA's category of workers reporting more than two hearing symptoms requiring further evaluation, n (%)		X^2	*p*-value[a]
	Yes (n=14)	No (n=23)		
Work groups				
Laundry workers	8 (57)	12 (52)	0.087	0.769
Mechanical cutters	6 (43)	11 (48)		
Noise exposure categories				
<85dB(A)	10 (71)	15 (65)	0.153	0.695
≥85 dB(A)	4 (29)	8 (35)		
Duration of working years				
< 9	4 (29)	3 (13)	7.840	**0.049***
10-19	1 (7)	10 (43)		
20-29	0 (0)	2 (9)		
30-39	9 (64)	8 (35)		

Statistical test - Pearson Chi-Square; *p<0.05

4.0 DISCUSSION

This study reported important findings with regards to noise exposure and hearing symptoms involving support group workers in a teaching hospital. The mean noise exposure level measured among laundry workers was found to be significantly lower than mechanical cutters (p=0.001). This finding contradicted with the findings from previous studies (Fontoura et al., 2014; Elias, Ijaduola and Sofola, 2003). Higher noise exposure levels were reported at the laundry unit of Public Federal Hospital in Brazil and Laundry Department of Lagos University Teaching Hospital (LUTH) in Nigeria, ranging from 77 to 99 dB(A) and 101 dB(A), respectively. This contradiction could also be due to the different environmental noise exposure. Although the intensity of noise exposure was lower among laundry workers compared to mechanical cutters, they were exposed to noise for longer duration per week compared to cutters. It is well known that intensity, frequency, exposure duration and type of noise play crucial influence on increasing the risk of health hazard (i.e. occupational hearing loss) (Ahmed et al., 2001).

The Factories and Machinery (Noise Exposure) Regulation 1989 stated that the permissible exposure limit of an equivalent continuous A-weighted sound pressure level shall not exceed 90 dB(A) (FMA, 2015). The criterion for action (action level) adopted is 85 dB(A) that necessitates the implementation of activities to reduce the risk of NIHL. This study found that there were 10 out of 17 (59%) mechanical cutters but only 2 out of 20 (10%) laundry workers who were exposed to noise of more than 85 dB(A) (p=0.002). Although the mean noise level among laundry workers were below the action level, a worker at the sorting and folding section and a worker at the washing and drying section had exceeded the action level for noise exposure. Similar scenario was observed among majority of mechanical cutters especially grass cutters, with the highest level of noise exposure recorded being 90 dB(A). Fontoura *et al*. (2014) also found that the noise exposure level at sorting, washing, drying and spinning area had exceeded the 85 dB(A) level which resulted in 18.9% of the workers diagnosed with NIHL. Similarly, they found that the folding area had slightly lower level (84 dB(A)) of noise exposure. The low level of noise at the folding area in the laundry unit may be due to its location which was farther away from the machineries (washer or dryer).

Similar to previous finding, the noise exposure level among mechanical cutters in this study was higher than action level maybe due to being in closer proximity to noisy equipment (Tengku Hanidza et al., 2013). They reported that grass cutters were exposed to an average noise level of 88 dB(A), ranging from 84 dB(A) to 92 dB(A). Although noise exposure levels between 80-85 dB(A) have only a small influence on hearing over the long term but in the high frequency range, these levels are capable of inducing measurable hearing threshold shifts in susceptible subjects (Plontke & Zenner, 2004). Normally, NIHL affects both sides of the ears due to noise exposure above 85 dB(A) (Ahmad Filza et al., 2013). Furthermore, the small number of noise induced hearing loss reported to the Social Security Organisation (SOCSO) may be due to underreporting or failure to capture workers' morbidities especially in the small and medium size enterprises (SME) in Malaysia (Hashim et al., 2005). Nonetheless, Berglund and Lindvall (1995) reported an estimated 15-20% of the working population in industrial countries

affected by sound pressure levels of 75-85 dB(A). They also reported that to protect the majority of people from being moderately annoyed, the sound pressure level should not exceed 50 dB(A) during the daytime and 45 dB(A) during the night time (outdoors).

Based on ASHA's category of hearing symptoms, more laundry workers reported hearing symptoms compared to mechanical cutters, although it was not significant. However, there was significantly higher proportion of laundry workers reporting hearing problem in noisy background compared to mechanical cutters. Interestingly, even though more mechanical cutters were exposed to occupational noise exceeding the action level, the reported hearing problem among the laundry workers could be due to previous noise exposure at the old laundry building. Majority of the workers had been working in an enclosed building with potentially higher noise level before moving into the current building in 2013. Unfortunately, no previous noise measurement was conducted hence the suspicions could not be proven.

It was found that only 29% among all respondents with noise exposure of more than 85 dB(A) had hearing loss symptoms (Table 5). The small percentage may be due to homogenous level of exposure and small number of affected workers. In this study, all six (43%) mechanical cutters who reported more than two hearing symptoms were workers performing hand grass cutting. This might be contributed by high intensity of noise exposure and the proximity of the machine to the workers' ears, with the highest recorded noise exposure level being 90 dB(A). Tengku Hanidza et al. (2013) reported in their study that 28% (n=5) of grass cutters at Universiti Putra Malaysia experienced hearing impairment.

Increasing employment years was found to be significantly associated with hearing symptoms. The duration of employment may also reflect the cumulative duration of noise exposure. Higher year of employment may also relatively indicate higher age. A local study among airport workers showed that workers who are more than 40 years old had four times higher incidence of hearing impairment (Nasir & Rampal, 2012). However, this association was not found in the present study despites the mean age of workers were above 40 years. Nevertheless, this may indicate that hearing symptoms in this study were not due to older age but solely related to longer year of employment.

Although workers in this study were aware of occupational noise exposure, the usage of hearing protection devices (HPD) was below the targeted compliance rate of 100% as 86% of the workers did not use HPD during work. This was similar to a previous study where only 5% of factory workers regularly wore HPD despite 80.5% of them being provided with HPD (Maisarah & Said, 1993). Tengku Hanidza et al. (2013) also reported poor compliance in PPE usage among their respondents due to discomfort. In addition to discomfort, Daniel (2007) added other reasons such as safety concerns, design, lack of knowledge related to NIHL and peer pressure. Ahmed et al. (2001) reported that education level of the workers was positively related to the use of the ear protection ($p=0.03$). It is very important to take several preventive strategies such as using earplugs, reducing the duration of exposure and keeping a safe distance from the source in controlling the risk, thereby preventing NIHL (Manakandan & Jaafar, 2017).

5.0 CONCLUSION

Mechanical cutters have higher 8-hours noise exposure level with short duration of hours weekly exposure while laundry workers have lower noise exposure level but longer hours of weekly exposure. Laundry unit reported significantly higher proportion of workers with hearing symptoms associated with work employment. The use of HPD is also poor in both groups indicating the need for appropriate education and training on noise exposure and hearing effects as some workers were found to be exposed to excessive noise level. Although some of these workers showed evidence of tendencies to have impairment, there is no evidence to specifically indicate that it is caused by excessive noise exposure related to their work. It can only be speculated that they are at risk of acquiring NIHL because of their noise exposure at work exceeding the action level.

The hearing symptoms were self-reported hence may lead to data misreporting. Ideally, hearing loss should be measured using pure tone audiometric (PTA) test which is more accurate. The presence of hearing problem due to occupation may have been missed as it was based on self-reporting and no baseline PTA data was previously recorded during pre-employment stage. This may further limit us in establishing if the NIHL is due to current workplace or past workplace exposure. In 2015, Hearing Conservation Programme (HCP) was initiated and the PTA testing is still under progress hence not included in this paper due to incomplete data. Moreover, the Occupational Safety and Health Unit has made an effort by involving with the Systematic Occupational Health Enhancement Level Programme (SoHELP), establishing a partnership with the Department of Safety and Health (DOSH). Future research with longitudinal study design could show the trend of noise exposure and hearing effects among workers. Through continuous monitoring, researchers could study other factors and determine causal relationship between noise exposure at work and NIHL. It is noteworthy that even with the mentioned limitations, this study has achieved its objectives according to the limited time and resources.

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