Sains Malaysiana 46(2)(2017): 267–274
http://dx.doi.org/10.17576/jsm-2017-4602-11

Prevalence of Hearing Loss and Hearing Impairment among Small and Medium Enterprise Workers in Selangor, Malaysia

(Kelaziman Kehilangan Pendengaran dan Kecelaan Pendengaran antara Pekerja Perusahaan Kecil dan Sederhana di Selangor, Malaysia)

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ABSTRACT

Factories and Machinery (Noise Exposure) Regulation 1989 has always demanded employer to protect workers from noise exposure ≥85 dB. However, noise induced hearing loss (NIHL) has been the highest notifiable occupational health issue among Malaysian workers in 2014. A cross-sectional study aimed to investigate the prevalence of hearing loss (HL) among 146 adult manufacturing workers with noise exposure ≥85 dB was carried out in Selangor. Pure tone audiometry and a validated questionnaire were used to determine the hearing status and information of the respondents. The results showed that the prevalence of HL was 73.3% and the prevalence of hearing impairment was 23.3%. Male workers (63.0%) had higher prevalence of HL than female workers (36.4%). Mean hearing threshold levels of HL respondents were significantly higher than respondents with normal hearing. It was discovered that among workers with employment of more than 10 years, > 80% of them suffered from HL. Association between employment years and hearing condition (normal, non-bilateral and bilateral HL) was statistically significant, $\chi(4)= 10.51$, $p=0.033$, with Kendall tau-c correlation showing positive and weak ($p=0.18$) association. Highest HL cases were found at 4 and 6 kHz. World Health Organisation and Factories and Machinery (Noise Exposure) Regulation 1989 classification on degree of hearing impairment showed slight to moderate hearing impairment among the respondents and both standards did not differ much (8.9% vs 6.9%, respectively). As a conclusion, prevalence of hearing loss and hearing impairment among manufacturing workers were high. Age, male sex, monthly salary and employment years were possible influencing factors.

Keywords: Audiometric test; degree of hearing impairment; manufacturing workers; noise induced hearing loss; prevalence

ABSTRAK

Peraturan Kilang dan Jentera (Pendedahan Bunyi Bising) 1989 sentiasa menuntut majikan untuk melindungi pekerja daripada pendedahan bunyi bising ≥85 dB. Walau bagaimanapun, kehilangan pendengaran akibat bunyi bising (KPABB) masih merupakan isu kesihatan pekerjaan yang paling banyak dilaporkan terjadi dalam kalangan pekerja di Malaysia pada tahun 2014. Suatu kajian keratan lintang yang bertujuan untuk mengkaji kelaziman kehilangan pendengaran (HL) dalam kalangan 146 pekerja dewasa sektor pengilangan yang didedahkan kepada bunyi bising ≥85 dB telah dijalankan di Selangor. Ujian audiometrik dan soal selidik digunakan untuk menentukan status pendengaran dan maklumat daripada responden. Keputusan kajian menunjukkan bahawa kelaziman HL adalah 73.3% dan kelaziman kecelaan pendengaran adalah 23.3%. Pekerja lelaki (63.0%) mempunyai kelaziman HL yang lebih tinggi daripada pekerja wanita (36.4%). Purata tahap ambang pendengaran responden HL adalah lebih tinggi daripada responden berpendengaran normal. Dalam kalangan pekerja yang berpengalaman bekerja lebih daripada 10 tahun, 80% daripada mereka menghidapi HL. Terdapat perkaitan antara pengalaman kerja dengan keadaan pendengaran (normal, tidak bilateral dan bilateral HL) secara statistik, $\chi (4) = 10.51$, $p=0.033$, dengan kolerasi Kendall tau-c menunjukkan ($p=0.18$) perhubungan yang positif dan lemah. Kes HLKP yang paling tinggi adalah pada frekuensi 4 dan 6 kHz. Klasifikasi tahap kecacatan pendengaran oleh Pertubuhan Kesihatan Sedunia dan Peraturan Kilang dan Jentera (Pendedahan Bunyi Bising) 1989 menunjukkan tahap kecacatan pendengaran responden adalah ringan kepada sederhana dan keputusan kajian berdasarkan kedua-dua piawaian tidak banyak berbeza (masing-masing 8.9% dan 6.9%). Kesimpulannya, kelaziman kehilangan pendengaran dan kecelaan pendengaran dalam kalangan pekerja sektor pengilangan adalah tinggi. Faktor yang berkemungkinan mempengaruhi HL adalah umur, lelaki, gaji bulanan serta pengalaman kerja.

Kata kunci: Kehilangan pendengaran akibat bunyi bising; kelaziman; pekerja pembuatan; tahap kecacatan pendengaran; ujian audiometrik

Introduction

Technology advancement has changed the traditional methods of doing work and hence has increased productivity. However, noise, a by-product of such advancement has been identified to affect the human hearing capability (Basu 2010). Noise induced hearing loss (NIHL) is undoubtedly prevalent in industrial countries (Reddy et al. 2012), with no exception for Malaysia as manufacturing industry is the major sector in this country. Despite the existence of many other industrial hazards, none of it so common and widespread like noise pollution (Maisarah 1993).

NIHL is characterized as sensorineural, bilateral type of hearing loss which affects the function of cochlear due to prolonged and cumulative noise exposure (DOSH 2010; El Dib et al. 2012; Reddy et al. 2012). Hearing loss is one of the most severe and highly occurred sensory deficits in human populations (Mathers et al. 2000). According to the new estimates of World Health Organization (WHO) on the magnitude of disabling hearing loss, more than 250 million people around the world are affected in 2000 and has since increased to 360 million people in 2012 (WHO 2012). About one third of people aged more than 65 years are affected in disabling hearing loss and it is particularly highest in South Asia, Asia Pacific and Sub-Saharan Africa. Factories and Machinery Act (FMA) defines hearing impairment as an average permanent hearing threshold level (HTL) of an employee at 0.5 k, 1 k, 2 k and 3 kHz which is shifted by 25 dB or more compared to the standard audiometric reference level. It differs from the WHO definition, in which hearing impairment refer to average of HTL for frequencies 0.5 k, 1 k, 2 k and 4 kHz which is shifted 25 dB or more. In addition, WHO classify degree of hearing impairment into none, slight, moderate, severe and profound level. However, no classification of degree of hearing loss or hearing impairment was available for FMA at the moment.

For the last 27 years, Factories and Machinery (Noise Exposure) Regulation 1989 demanded all workers with workplace noise exposure of 85 dB or more need to be protected. In Malaysia, there were 2648 cases of occupational disease (OD) and poisoning cases in 2014, where 1563 cases of investigated OD were of noise induced hearing loss (NIHL) which was the commonest OD experienced by Malaysian workers (78.1%) as compared with other diseases (DOSH 2014). According to a study on burden of NIHL among manufacturing workers in Malaysia, incidence risk of NIHL per 100,000 manufacturing workers projected to be 8%. The highest risk and incidence was among the motor vehicle parts industry (32%), followed by tobacco industry (23%) and fabricated metal industry (23%) (Tahir et al. 2014). This study aimed to investigate the prevalence of hearing loss (HL) as evidence to promote the hearing conservation program in the manufacturing industry of Malaysia. In addition, degree of hearing loss and hearing impairment were calculated for FMA by following the threshold categories as set by WHO classification.

Materials and Methods

Study Design and Respondents

This is a cross-sectional study which used baseline data of a Solomon four-group study aimed to increase the hearing protection devices use among manufacturing workers in small medium enterprises in Selangor. A list of Small Medium Enterprises (SMEs) of medium size manufacturing industries in Selangor was obtained from SME Corporation Sdn. Bhd. Manufacturing companies will be included on voluntarily basis. Inclusion criteria for this study was adult worker, 18 years old and above, with workplace noise exposure of 85 dB and above. With assistant from management of the manufacturing factories, a name list of workers who was known to be exposed to noise level of 85 dB and above was used to randomly select study respondents. In the baseline data, 146 manufacturing workers were involved with audiometric testing as part of the hearing protection intervention. These 146 workers were recruited to determine the prevalence of HL among manufacturing workers. Manufacturing factories that volunteered for this study comprised of air-conditioning manufacturers and auto mobile parts manufacturers.

Questionnaire and Audiometric Test

Respondents were required to answer a questionnaire developed in English and Malay language on socio-demographics and occupational information. Questionnaires were completed in a classroom setting with presence of two researchers to ensure that respondents fully understand the questions. Prior to audiometric test, respondents were asked if they experienced any accident affecting ability of hearing, or any inflammation in both ears at the time of interview. Respondents with such conditions were not included in this study.

Respondent underwent pure tone audiometry to determine their hearing status early morning before they start work in the production floor. Audiometric testing complied with Regulation 20 and 26 of requirement of Factories and Machinery (Noise Exposure) Regulations 1989. Respondents were advised to be free from noisy environment for at least 14 h before audiometric test was performed. All audiometric tests were conducted by a trained technician under supervision of registered occupational health doctor, using a duly calibrated portable diagnostic audiometer, Amplivox 240, with TDH49P headset. Tests were done in a calibrated silent cabin which was transported to the manufacturing factories, placing in a quiet room away from the noise sources. Calibration carried out for both audiometer and silent cabin meet the requirement of Second Schedule, Regulation 20(4)(c) of Factories and Machinery (Noise Exposure) Regulations 1989.

Recommended procedure for pure tone air conduction audiometry by British Society of Audiology was referred for audiometric testing procedures. Respondents were asked to press the response switch whenever he heard a tone from the headset. The lowest audible tone heard at

each frequency was recorded as the hearing threshold level (HTL). The HTLs of each ear was measured at frequencies 0.5 k, 1 k, 2 k, 3 k, 4 k and 6 kHz. HTLs were determined by screening the right ear first. Beginning the test with 1 kHz at 40 dB, the tone was gradually decrease incrementally by 10 dB until there was no response elicited by the respondents. At the level where there was no more response, the tone was increased incrementally by 5 dB until there was a response. The lowest sound tone heard was taken as the HTL. This process was repeated for 2 k, 3 k, 4 k, 6 k and 0.5 kHz. Similarly, the left ear testing followed as per procedure (British Society of Audiology 2011).

OPERATIONAL DEFINITIONS

Definitions below were according to Factories and Machinery (Noise Exposure) Regulation 1989. Hearing conditions in this study were divided into the following classifications:

Normal Hearing: Air conduction hearing threshold levels is <25dB at all test frequencies (0.5 k, 1 k, 2 k, 3 k, 4 k and 6 kHz); *Hearing Loss*: Air conduction hearing threshold levels is ≥25 dB at any frequency tested (0.5 k, 1 k, 2 k, 3 k, 4 k and 6 kHz); and *Hearing Impairment*: Arithmetic average of the permanent hearing threshold level of an employee at 0.5 k, 1 k, 2 k, 3 kHz which is shifted by 25 dB or more compared to the standard audiometric reference level.

STATISTICAL ANALYSIS AND ETHICAL ISSUE

Statistical Package for Social Sciences (SPSS) 21.0 was used for statistical analysis in this study. Statistical significance was set at $p<0.05$ level. The research protocol was approved by Research Ethics Committee of Universiti Putra Malaysia.

RESULTS

BACKGROUND OF THE RESPONDENTS

Socio-demographics of the respondents were shown in Table 1. Among 146 respondents enrolled in this study,

TABLE 1. Social demographics of respondents and respective average hearing threshold levels for right and left ears

Variables	N	%	Average hearing threshold level, dB	
			Right ear	Left ear
Gender				
Male	135	92.5	19.43 (9.66)	19.35 (9.15)
Female	11	7.5	13.56 (5.38)	14.62 (9.38)
Race				
Malay	136	93.2	18.53 (9.16)	18.73 (9.34)
Chinese	8	5.5	24.27 (13.72)	23.54 (7.29)
Indian	1	0.7	34	22
Others	1	0.7	23	16
Education level				
Primary School	3	2.1	17.78 (14.94)	16.39 (11.82)
Secondary School	117	80.1	19.53 (9.64)	19.29 (9.05)
Diploma	22	15.1	17.20 (8.88)	17.92 (9.98)
Undergraduate Degree	3	2.1	11.67 (1.67)	16.39 (13.24)
Doctorate Degree	1	0.7	20	23
Work position				
Operator/General worker	64	43.8	19.39 (9.88)	20.03 (10.49)
Supervisor	32	21.9	20.29 (10.28)	20.29 (8.49)
Executive	9	6.2	16.94 (9.19)	16.94 (9.19)
Others	41	28.1	17.78 (8.49)	17.78 (8.49)
Monthly income (RM)				
≤ 900	14	9.6	18.39 (8.98)	17.08 (11.32)
901 – 1500	62	42.5	18.58 (8.72)	19.99 (9.63)
1501 – 3000	61	41.8	19.33 (10.06)	18.10 (8.11)
> 3000	9	6.2	20.37 (12.98)	21.11 (10.34)
Work Duration				
<35	10	6.8	14.25 (6.82)	14.50 (7.91)
35-40	24	16.4	18.44 (8.94)	19.58 (8.59)
41-48	48	32.9	20.69 (10.05)	20.35 (10.38)
>48	64	43.8	18.65 (9.57)	18.45 (8.63)
Shift work				
Shift worker	40	27.4	17.06 (9.27)	17.40 (9.55)
Non-shift worker	106	72.6	19.71 (9.56)	19.59 (9.07)
Smoking Status				
Never	41	28.1		
Former smoker	32	21.9		
Smoker	73	50.0		

92.5% was male and 7.5% was female. Age of the respondents ranged from 19 to 58, with mean age 34.90 ±8.52. Majority of respondents in this study were Malays (93.2%) and was dominant by operator or general workers (43.8%). About 80% of the respondents had education up to secondary school level. Monthly income of the respondents was mainly fall in RM901-1500 (42.5%) and RM1501-3000 (41.8%) categories, followed by ≤RM900 (9.6%) and >RM3000 (6.2%). It was observed that 112 (76.7%) respondents were working more than 40 h per week, where 48 (32.9%) worked overtime (41-48 h per week) and 64 (43.8%) had extended overtime. Average HTLs (0.5 k - 6 kHz) for male workers were higher compared to female workers for left and right ears.

PREVALENCE OF HEARING LOSS AND HEARING IMPAIRMENT

Prevalence of hearing loss was 73.3% and hearing impairment was 23.3%. Comparison between genders showed that male workers (63.0%) had higher prevalence of hearing loss than female workers (36.4%). Prevalence of hearing impairment was 24.4% for male workers and 9.1% for female workers. In addition, prevalence of bilateral hearing loss was 50% and prevalence of bilateral hearing impairment was 8.2%. Prevalence of hearing loss at right or left ear was as shown in Table 2.

MEAN HEARING THRESHOLD LEVELS AND FREQUENCIES

Respondents with hearing loss at each frequency (0.5 to 6 kHz) were identified and illustrated in Table 3. The mean HTLs for respondents with hearing loss were ranged from 25.85-41.92 dB whereas mean HTLs for respondents with normal hearing ranged from 11.26-15.51 dB. Highest number of hearing loss cases were found at 4 kHz (63 cases) and 6 kHz (66 cases). Respondents were grouped into two categories based on their hearing condition (Table 4). Respondents with at least one hearing loss at any frequency were considered as hearing loss. One sample independent t-test was done to compare mean HTLs of respondents with normal hearing and respondents with HL. Mean HTLs of HL respondents were significantly higher than mean HTLs of respondents with normal hearing at all frequencies. Mean HTLs for respondents with normal hearing ranged from 7.56-13.59 dB whereas for HL respondents, it ranged from 17.38-28.27 dB. Higher mean HTLs were observed at high frequencies such as 4 and 6 kHz, which were ranged from 26.78-28.27 dB as shown.

DEGREE OF HEARING IMPAIRMENT AND HEARING LOSS

Based on the WHO classification for hearing impairment, 8.9% of the respondents had slight to moderate hearing impairment at better ear and 21.9% of them had slight to moderate hearing impairment at worse ear (Table 5). For

TABLE 2. Distribution of respondents with hearing loss or hearing impairment

Hearing condition	Total respondents, N (%)			
	Right ear	Left ear	Non-bilateral	bilateral
Hearing loss	91 (62.3)	89 (61.0)	34 (23.3)	73 (50.0)
Hearing impairment	25 (17.1)	21 (14.4)	22 (15.1)	12 (8.2)

*Respondents with at least one hearing loss at any frequency were considered as hearing loss

TABLE 3. Mean hearing threshold levels at respective frequencies for respondents with normal hearing or hearing loss at the respective frequencies

Frequencies (Hz)	Normal		Hearing loss	
Right ear	Mean HTLs , dB (SD)	N	Mean HTLs , dB (SD)	N
500	15.51 (4.04)	108	31.32 (9.84)	38
1000	13.43 (4.84)	118	33.21 (11.96)	28
2000	11.61 (5.83)	115	31.29 (8.06)	31
3000	11.26 (6.52)	111	33.71 (9.58)	35
4000	11.69 (6.78)	83	35.71 (11.74)	63
6000	11.86 (6.56)	94	41.92 (15.79)	52
Left ear				
500	14.87 (4.62)	117	28.79 (6.90)	29
1000	13.44 (5.66)	125	25.85 (6.50)	21
2000	11.89 (6.11)	114	28.75 (5.54)	32
3000	12.94 (6.40)	97	29.59 (10.66)	49
4000	12.50 (6.33)	90	34.50 (12.86)	56
6000	11.75 (7.16)	80	37.20 (14.47)	66

*Normal: There is no hearing loss at the stated frequencies
*Hearing loss: There is hearing loss (≥25 dB) at the stated frequencies
e.g. 108 respondents had normal hearing at 500 Hz and 38 respondents had hearing loss at 500 Hz

TABLE 4. Comparison of mean average HTLs of 0.5-6kHz for respondents grouped under normal hearing or hearing loss categories

Frequency (Hz)	Mean HTL, dB (SD)		95% CI	t (df)	*p* value
	Normal (*n*=39)	Hearing loss (*n*=107)			
Right ear					
500	13.59 (4.28)	21.82 (9.58)	5.95-10.51	7.15 (138.16)	<0.001
1000	11.41 (5.25)	19.35 (10.90)	5.27-10.60	5.89 (133.30)	<0.001
2000	8.46 (5.98)	18.46 (10.22)	7.27-12.72	7.27 (115.22)	<0.001
3000	7.56 (7.42)	19.95 (11.79)	9.13-15.65	7.53 (107.42)	<0.001
4000	9.10 (6.27)	26.78 (14.59)	12.80-24.65	6.25 (144)	<0.001
6000	8.85 (6.54)	27.57 (18.25)	14.67-22.78	9.13 (144)	<0.001
Left ear					
500	12.82 (3.94)	19.39 (7.82)	4.62-8.52	6.67 (129.68)	<0.001
1000	10.90 (5.37)	17.38 (7.99)	3.75-9.22	4.69 (144)	<0.001
2000	8.46 (5.98)	18.18 (8.81)	7.18-12.26	7.59 (99.56)	<0.001
3000	10.13 (7.21)	22.99 (12.03)	9.62-16.11	7.85 (112.70)	<0.001
4000	9.87 (5.90)	26.78 (15.51)	13.40-20.41	9.54 (143.69)	<0.001
6000	9.49 (7.50)	28.27 (16.50)	14.84-22.73	9.41 (137.20)	<0.001

*Normal: <25dB for average HTL (0.5-6kHz)
*Hearing loss: ≥25dB for average HTL (0.5-6kHz)

TABLE 5. Distribution of degree of hearing impairment by FMA and WHO classification

	FMA hearing impairment, N (%) (Average of 0.5, 1 k, 2 k, 3 kHz)				
	No ≤25 dB	Slight 26-40 dB	Moderate 41-60 dB	Severe 61-80 dB	Profound ≥81 dB
Better ear	136 (93.2)	8 (5.5)	2 (1.4)	-	-
Worse ear	118 (80.8)	22 (15.1)	6 (4.1)	-	-
	WHO hearing impairment, N (%) (Average of 0.5, 1 k, 2 k, 4 kHz)				
	No[a] ≤25 dB	Slight[b] 26-40 dB	Moderate[c] 41-60 dB	Severe[d] 61-80 dB	Profound[e] ≥81 dB
Better ear	133 (91.1)	12 (8.2)	1 (0.7)	-	-
Worse ear	114 (78.1)	26 (17.8)	6 (4.1)	-	-

*According to WHO classification of degree of hearing impairment at better ear:
[a] No or very slight hearing problems. Able to hear whisper
[b] Able to hear and repeat words spoken in normal voice at 1 metre
[c] Able to hear and repeat words using raised voice at 1 metre
[d] Able to hear some words when shouted into better ear
[e] Unable to hear and understand even a shouted

FMA classification, 6.9% of the respondents had slight to moderate hearing impairment at better ear, whereas for worse ear 19.2% of the respondents suffered from slight to moderate hearing impairment. Classifications of WHO were used to express the degree of hearing loss among 146 respondents. Average HTLs of 0.5 k, 1 k, 2 k, 3 k, 4 k, 6 kHz ranged from 1.67-50.83 dB. It was observed that 13.7% of respondents suffered from mild to moderate hearing loss at better ear and 30.9% had mild to moderate hearing loss at worse ear (Table 6).

BILATERAL HEARING LOSS AND EMPLOYMENT YEARS

Respondents were categorized into three groups of employment years (Table 7) which were 0-10 years (63.0%), 11-20 years (22.6%) and 21-30 years (14.4%) of working experience in the current company. Through Pearson Chi-Square test, there was a statistically significant association between employment years and hearing condition, χ (4) = 10.51, p=0.033. The level of association as shown by Kendall tau-c correlation was positive and weak (p=0.18).

DISCUSSION

According to findings of studies in various countries, hearing loss and hearing impairment were positively related to age, male sex and middle- and low-income regions, previous and current exposure time to high noise

TABLE 6. Distribution of respondents according to degree of hearing loss

	Degree of hearing loss Average HTLs 0.5, 1, 2, 3 , 4, 6KHz, N (%)				
	Normal <25 dB	Mild 25-40 dB	Moderate 41-60 dB	Severe 61-80 dB	Profound ≥81 dB
Better ear	126 (86.3%)	19 (13.0%)	1 (0.7%)	-	-
Worse ear	101 (69.2%)	36 (24.7%)	9 (6.2%)	-	-
Right ear	114 (78.1)	26 (17.8)	6 (4.1)		
Left ear	113 (77.4)	29 (19.9)	4 (2.7)		

TABLE 7. Chi-square association between hearing condition and employment years

Employment years	Hearing condition, N (%)				Chi-square (df), *p* value
	Normal	Non-bilateral HL	Bilateral HL	Total	
0-10	29 (31.5)	25 (27.2)	38 (41.3)	92 (100.0)	10.51 (4), 0.033
11-20	6(18.2)	8 (24.2)	19 (57.6)	33 (100.0)	
21-30	4 (19.0)	1 (4.8)	16 (76.2)	21 (100.0)	

*Kendall's Tau-c= 0.180, p=0.005

levels (Reddy et al. 2012; Stevens et al. 2013). In light of these influencing factors, analysis regarding age, gender, monthly salary and employment years were done.

Age of the respondents ranged from 19 to 58 years old, with mean age 34.90 ±8.52 years old. Age of the respondents was controlled below 65 years old to avoid the possible occurrence of presbycusis, which is a condition of hearing loss that gradually occurs when people grow older. According to World Health Organization, one third of people more than 65 years old are affected by disabling hearing loss. Prevalence for this age group is highest in South Asia, Asia Pacific and sub-Saharan Africa (WHO 2012).

As shown in Table 1, about half of the respondents were operator or general workers and 80% of them had education up to secondary school level. More than 80% of them earned RM900 to RM3000 a month and 76.7% respondents worked more than 40 h per week. HTLs for both ears for secondary school level group were found to be higher than that of other workers with different education levels. Furthermore, HTLs for operator, general workers and supervisor were also higher than executive and other workers. Operator, general workers and supervisors normally work more than 40 h per week near noise sources. Thus, it can be assumed that low socioeconomic groups were at greater risk of developing hearing loss, which is similar with findings from Filza Ismail et al. (2013).

Male workers had higher prevalence of hearing loss and hearing impairment than female workers. Findings were supported by several studies in assessing hearing loss among workers (Feder et al. 2015; Hasson et al. 2011; Tahir et al. 2014). Possible reasons referring to previous literatures include greater noise exposure in occupational settings, different exposure to smoking, atherosclerosis, or other potential risk factors for hearing loss (Cruickshanks et al. 1998; Siegelaub et al. 1974) such as inherent anatomical and physiological differences which influence the basic auditory sensitivity and susceptibility to hearing loss, including levels of endogenous steroid hormones (estrogen and progesterone) on the cochlear response to noise (McFadden 2000). According to the findings of the study conducted by McFadden (2000), there was a strong link between levels of endogenous steroid hormones and individual's susceptibility to NIHL. Estradiol was found to be protective against NIHL and females had higher and more variable levels of serum estradiol than males. Estradiol was believed to have certain effect at the level of the stria vascularis of the ears, such as marginal cells or vascular tissue.

Table 7 shows that prevalence of unilateral and bilateral hearing loss of workers with 0-10 years (68.5%) of employment years in the current company was lesser as compared to 11-20 years (81.8%) and 21-30 years (81%). Thus, hearing problems of the workers after more than 10 years of working in high noise environment were significant since more than 80% of them suffered from hearing loss. This was in accordance with other studies that workers developed permanent hearing loss if occupational noise exposures were more than 10 years (Geovanna et al. 2014). In fact, other researchers stated that hearing losses at 3 k, 4 k and 6 kHz for NIHL will finally reach a maximum level in 10 to 15 years under stable noise exposure condition (Bergström & Nyström 2009; Dobie 1990). With all these findings, hearing loss or hearing impairment in this study were found to be positively related to age, male sex, monthly salary and employment years as discussed earlier. However, further analysis need to be done to fully understand about the relationships between them.

Prevalence of hearing loss (73.3%) for manufacturing workers in this study was considered high compared to other local studies of different industries such as 57.0% in quarry workers (Filza Ismail et al. 2013), vector control workers 26.0% (Masilamani et al. 2014). When compared to the hearing loss prevalence of workers in other countries, the prevalence of respondents in this study showed a more severe condition as it was higher. Prevalence of hearing loss in other countries included 22% among New York farmers (Hwang et al. 2001), 56.8% among Nigerian steel rolling mill workers (Ologe et al. 2006), 44.2% among Brazilian metallurgical workers (Geovanna et al. 2014) and 47.0% among Tanzanian miners (Musiba 2015).

Through observation, respondents often exposed to a variety of manufacturing processes, machinery and equipment which produce high noise levels and these can affect the ear. For example, high noise was generated by dumping sheared parts into racks or metal recycling bins, stacking sheet metal, small and medium stamping machines. Daily sources of man-made noises such as from grinding, shearing, punching, forming, hammering activities in a manufacturing factory are common. Hearing loss seems not to be taken serious by some of the workers because they feel that it is not a life-threatening injury and some even thought that it is curable (Maisarah 1993; Rus et al. 2008). Workers were always unaware of their hearing problems if it did not affect their capability of listening to speeches.

Exposure to excessive noise at workplace affect higher frequencies more, with most of the hearing loss cases happened to study respondents at frequencies 4 and 6 kHz as shown in Table 3. The destructive nature of excessive loud noise to high frequencies was very well studied. NIHL primarily affects the high frequencies region, such as 3 k, 4 k and 6 kHz and then spread to lower frequencies such as 0.5 k, 1 k and 2 kHz (Chen & Tsai 2003; Kitcher et al. 2014; Maisarah 1993; Ologe et al. 2006). Although at the moment we could not conclude that hearing loss experienced were NIHL, there is possibility that our respondents may suffer from NIHL since some of them do have some of the characteristics of NIHL. Further investigation including pure tone bone conduction audiometry, tympanometry or otoscopy are needed for confirmation of NIHL occurrence among the study respondents.

There is a diversity of definitions of hearing impairment worldwide, thus comparison among studies is difficult and invalid. In this study, WHO classification was used to classify hearing impairment according to the average HTLs in the better hearing ear. In Factories and Machinery (Noise Exposure) Regulation 1989, no specific classification was found for degree of hearing impairments. There is a need for a common language among professionals and meaningful interpretations for clients, thus a classification on hearing impairment in Malaysia should be introduced. Hence, the degree of hearing impairment among respondents were calculated based on the range of HTLs of WHO classification except average HTLs of frequencies 0.5 k, 1 k, 2 k and 3 kHz were used. Although different frequencies were used, there was not much difference observed in both standards. A total of 6.9% respondents based on FMA classification and 8.9% respondents based on WHO classification suffered from slight to moderate hearing impairment. These respondents might experience some difficulties in hearing conversations but they are still fit for communications (WHO 2012). None of the respondents was experiencing severe or profound hearing condition. These findings showed that most of the study respondents were at early stages of hearing impairment which is similar with study done by Filza Ismail et al. (2013).

Conclusion

Prevalence of hearing loss and hearing impairment among manufacturing workers were high as compared to other industries locally and internationally. Further investigations are necessary to determine whether study respondents were suffering from NIHL, as well as to clarify the relationship of hearing loss and hearing impairment with age, male sex, monthly salary and employment years. Hearing conservation program should be promoted to reduce NIHL. A classification of degree of hearing impairment should be created in Malaysia to interpret the severity of hearing loss affecting speech understanding and communication.

Acknowledgements

The authors wish to thank all respondents involved, kind support from management of manufacturing factories for excellent assistance in this study. This study was funded by Putra Grant of Universiti Putra Malaysia (GP-IPS/2013/9399831).

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Received: 10 March 2016
Accepted: 16 May 2016