ORIGINAL ARTICLE

Noise Hazard And Hearing Loss Among Mold Manufacturing Worker Industry In Penang

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Abstract: Introduction: Exposure to occupational noise from process of mold manufacturing may cause workers experiencing hearing disorder. Present study shall focus on association of employee sociodemographic, occupational information and social lifestyle against prevalence of hearing disorder among the mold manufacturing workers. Method: A cross sectional study were conducted among 40 workers from a mold manufacturing company. Personal noise monitoring had also been carried out for workers to determine noise exposure level LEX, LMAX and LPEAK during their 8 hours work shift whereas the hearing threshold was obtained from recent annual audiometric test record carried out by DOSH approved mobile audiometric centre. Statistical analysis using Pearson correlation and Chi-Square has been carried out to test the relationship between the variables (IV and DV). Results: It was found that primarily, the age of mold manufacturing workers were significantly correlated with LHL [rs = - 0.311, P = 0.025], RHL [rs = - 0.289 P=0.035], LSTS [rs = - 0.349, P = 0.014] and RSTS [rs = - 0.349, P = 0.014]. LEX was correlated with RHL only [rs = - 0.27, P = 0.046]. Age was also correlated with overall HD [rs = - 0.351, P = 0.013]. Despite provided with PHP, recommended based on the calculation of the noise attenuation below NEL, hearing disorder were still observed among the employees. Surprisingly, the trend of presbycusis were observed among workers below the age of 30 years old where in some cases they were non-occupationally related.

Conclusion: It is not a surprise that age and Lex of the mold manufacturing workers were associated with prevalence of hearing disorder among mold manufacturing workers. However, further research or investigation should be carried out to consider non-occupational factors which may affect the worker's hearing threshold.

Keywords: mold manufacturing, noise exposure, hearing loss, hearing disorder

1.0 INTRODUCTION

Noise is known as a common occupational health hazard [1]. The most recent WHO (World Health Organization) estimate suggests that approximately 466 million people (or 6.1% of the world's population) were living with disabling hearing loss in 2018 [2]. This estimate is projected to rise to 630 million by 2030 and to over 900 million by 2050 . WHO had also predicted that number of people from East Asia & Pacific who suffering from hearing loss shall increase from 47 million (2018) to 95 million (2050). Asian laborers are the ones who have highest number of healthy years lost due to NIHL (Noise Induced Hearing Loss) in comparison to laborers from other regions of the world [3]. This had been

caused due to constant increase of establishment of industries in Asia which needs labour to drive its productivity.

Figure 1 shows on ONRHD (Occupational Noise Related Hearing Disorder) which had been reported to SOCSO (Social Security) by Malaysian workers from the year 2008 till 2017. The number of ONRHD reported for compensation had been on increasing year after year due to many workers had been coming forward to report and claim compensation for their affected hearing. As we know this is only the tip of iceberg and there are more underlying cases which are not been reported by workers who are living with ONRHD for their lifetime. As been presented in many literature studies, ONRHD is preventable.

ONRHD cases in manufacturing industries had been increasing year after year. As per DOSH (Department of Occupational Safety & Health) statistic, 88% (2478 cases) of occupational health diseases which had been reported in 2017 are related to occupational noise related hearing disorder. The report also revealed that industries which produces rubber and plastic products, fabricated and basic metal products, food products and beverages and textile industry reported significant cases of hearing disorder [4]. A few medical studies have shown evidence indicating that noise problems have caused physical and psychological disorders e.g., stress [5] and physiological effects e.g., increasing blood pressure and causing hypertension [6]. The increase of number of ONRHD had been impacting the life of the affected workers. Individuals with ONRHD may experience significant morbidity due to hearing loss, concomitant tinnitus and /or impaired speech discrimination adversely affecting the worker's communication and safety leading to depression, social isolation, and accident [7]. The impact of ONRHD on the workers life is too dangerous to be ignored.

Risk factors such as age [8], gender [9], hobby [19], work experience [10], job role [11], smoking habit [11] and noise exposure level [12] which causes workers to experience hearing disorder.

The main characteristics of ONIHL are that most noise exposures are symmetric and display typical signs of notching at high frequencies of 3000, 4000, or 6000 Hz with recovery at 8000 Hz in audiogram testing [10]. This notch presents at one of these frequencies and does not actually influence neighbouring frequencies but once a notch occurs, additional frequencies may demonstrate notches,

and the prominence of this notch may be affected by age-related hearing loss [10]. Therefore, ONIHL needs to be differentiated from age-related hearing loss in older persons.

The age groups from 30-44 and 45-59 years are at higher risk when exposed to occupational noise, corresponding to the ages of peak labour force participation [20]. A previous study showed that the affected fraction decreased by age group after 30-44 years old [9], indicating the heavy impact of occupational noise on the burden of hearing loss at younger ages [9]. If people suffering from hearing loss at a younger age have a longer duration of disability, then more years of disability contribute to the disability-adjusted life year (DALY) calculation.

Previous studies have shown that males experience more effects after exposure to occupational noise than females [9]. This may be due to male workers typically having superior exposure to noise at work than female worker due to differences in occupational categories, economic sectors of employment, and lifetime work history. Another possible reason is the hormone-driven physiological differences between sexes. Several animal and human studies have demonstrated that women may be protected against hearing loss because of estrogen and it's signalling pathways [27].

It has been reported that up to 50% of individual variations in people with ONIHL may be associated with hereditary factors [21]. In addition, individual demographic factors such as age, pre-existing sensorineural hearing loss, chronic diseases (e.g., hypertension and diabetes mellitus), history of smoking, and use of ototoxic medications may influence the degree of damage to the inner ear caused by noise injury [22].

Hobby such as playing musical instruments, diving, attending Zumba, concerts with loud music may cause NIHL to individual. These hobbies may create excessive noise that might affect the hearing of individual that attends or practice the hobby.

Work duration may differ according to workplace. There is workplace which require the employee to work for 12 hours or 8 hours depending on business needs. The Malaysian Employment Act 1955 had stipulated that a worker is permitted to work for a maximum of 48 hours in a week. Employers shall determine the workers work pattern or shift in the context of in compliance with section 60a of The Malaysian Employment Act 1955. Industry Code of Practice for Management of Occupational Noise Exposure and Hearing Conservation 2019 had also come up with a reference table

for the employer on the daily exposure noise limit as per noise level produced at workplace. The higher the daily noise exposure, less the amount time workers can perform their job at the workplace. Duration of work at a workplace is an important risk factor which may cause hearing disorder among workers. Rabinowitz et al [12] mentioned in his study that noise can cause permanent hearing loss at chronic exposures equal to an average SPL of 85dB or higher for an 8-hour period. Based on the logarithm scale a 3dB increase in SPL represents a doubling of the sound intensity. Therefore, 4 hour of noise exposure at 88dB is considered to provide the same noise dose at 8hour at 85dB.

Work that been carried out by workers at workplace is an important risk factor need to be studied. Different type of work been carried out by workers would emit different noise level. Past studies had revealed that profession such as referees [24], factory workers especially stone grinder [25], and night club employees [26] are tinnitus related profession. The task been carried out by referee which blowing the whistle is one of the high noise tasks which expose the profession to risk of tinnitus. Frequency of the referee blowing his whistle X noise level generated each time whistle was blown would be risk factor affecting the hearing of the referee. Therefore, profession as referee had been regarded as tinnitus profession.

Gitanjali et al. [23] had demonstrated the association between noise and autorickshaw drivers who were exposed to high level noise (who did not wear hearing protector). Autorickshaw drivers been exposed to loud traffic noise and the autorickshaw motor noise during the period of their work. Extensive long hours of work by autorickshaw drivers had been a contributing factor causing autorickshaw drivers having hearing disorder. Many of the autorickshaw drivers had been in the same profession for many years would make their hearing condition worse.

Mold or die is a tool that converts the resins or molten zinc into intended product through a thermodynamic cyclic flow. A mold manufacturing industry may consist of process such as CNC (Computer Numerical Control) Steel machining, CNC Graphite, Heat Treatment, EDM (Electro Discharge Machining), Mold Assembly and Mold Testing. Mold manufacturing consist of multiple subprocess with produce high noise which may cause hearing disorder among its workers. Process such as usage of pressurized air gun, gun wrench, mold matching process, grinding and CNC milling are subprocess of mold manufacturing which creates high noise at workplace. Thus, this study intends

to determine the relationship between prevalence of hearing disorders with current noise exposure at workplace, sociodemographic background, occupational history, and social lifestyle of the employees in a mold manufacturing company.

2.0 METHOD

A cross sectional study was carried out on 40 out of 72 workers (power of 31.5%) of mold manufacturing plant in Penang. The sampling strategy was to include those workers who are working at work area with noise level above 80dB. Balance 32 workers were working in processes with noise level below 80dB.

Questionnaire were used to collect information on age, gender, work experience, hobby, role, department, and smoking habit of the mold manufacturing workers. 3M Noise Pro Personal Dosimeter were used to measure noise exposure level in terms of L_{EX}, L_{MAX} and L_{PEAK} at their respective department. The method of measuring noise in this study had been adopted from Industry Code of Practice for Management of Occupational Noise Exposure and Hearing Conversation 2019.Pre-calibration of dosimeter were carried out by using calibrator. Adjust the range to ensure the 3M Noise Pro Personal Noise Dosimeter is showing reading of 114dB as per noise produced by calibrator. Microphone of dosimeter was fixed on the shoulder at the collar of shirt. Upon completion of monitoring, post calibration was carried out to ensure collection of data valid to be used for this study. 3M Detection Management Software had been used to transfer the noise data from dosimeter.

Hearing threshold was obtained as secondary data from the annual pure tone air conduction audiometric test conducted by competent audiometric technician of a DOSH approved/registered mobile audiometric test center. Workers were given 14 hours of rest from any noisy environment prior the pure tone audiometric test been conducted. Upon completion of audiometric testing, OHD (Occupational Health Doctor) had interpreted worker's audiogram and conducts physical examination of worker's ear conditions.

Microsoft Excel sheet were used to record and calculate hearing impairment (HI), hearing loss (HL) and standard threshold shift (STS) for both left ear (L) and right ear (R) respectively as well as hearing disorder, HD (presence of HI, HL and STS in any ear). The data were then transferred to SPSS

for bivariate analysis using Spearman correlation for continuous data whereas Chi-Square test of independence were used for categorical data (depending on normality of the data).

3.0 RESULTS

Based on the data collected, mean age of the mold manufacturing workers are 38.25(10.14). Majority of the respondent (77.5%) were ≥30years and only (22.5%) < 30 years old. Male respondent was 97.5% meanwhile female respondent was 2.5%. The respondents were mostly from Mold Assembly department (42.5%) followed by CNC Steel (27.5%), Grinding (12.5%), Graphite and Mold Testing (7.5%) and Heat Treatment (2.5%). There were 57.5% of Machinist and 42.5% Toolmaker involved from the total respondent. In terms of years of experience, mean workers experience is 9.27(9.77). There were 62.5% of workers with working ≤ than 20 years. There were 37.5% of workers with >20 years of working experience department they are working. In terms of smoking habit, there were 42.5% smoker and 57.5% non-smoker.

Data collection of daily noise exposure limit of workers reveal that 57.5% of workers in mold manufacturing was exposed with noise level equal or lower than 84.9dBA meanwhile 42.5% of workers were exposed with daily noise level of more than 85dBA. 57.5% of workers had been exposed to mean L_{EX} of 83.1dBA. Another 42.5% of workers had been exposed to mean L_{EX} of 90.9dBA.

A total of 67.5% of workers were exposed with noise level equal or less than 114.9 dBA with mean L_{MAX} of 110.1dBA. Another 32.5% of workers were exposed noise level more than 115dBA with L_{MAX} of 116.5dBA. Majority of mold manufacturing workers (70%) were exposed to noise level above 140dBC with mean L_{PEAK} of 143.9dBC. Other 30% of workers were exposed to noise level equal or lower than 140dBC with mean L_{PEAK} of 130.2dBC.

Based on data collected, 7.5% of workers were having left ear hearing impairment (LHI) meanwhile 4% of workers were having right ear hearing impairment (RHI). Hearing loss data collection revealed that 75% of workers were having left ear hearing loss (LHL) and 65% of workers were having right ear hearing loss (RHL). Standard threshold shift data shows that 5% of workers are having left ear standard threshold shift (LSTS) and right ear standard threshold shift (RSTS). There were two employees from Mold Assembly department were having standard threshold shift for both left and right ear during this study. Out of 40 audiograms, we had found 33 workers were having

hearing disorder which would be related to hearing impairment, hearing loss and standard threshold to either ear. Only 7 workers (17.5%) don't have any types of hearing disorder. Of those having hearing loss, the study shows 2(5%) severe hearing loss, 7(17.5%) moderate hearing loss and 24(60%) mild hearing loss.

Specifically, age was correlated with LHL [rs=-0.311 P=0.025 N=40] and RHL [rs=-0.289 P=0.035 N=40]. L_{EX} correlated with RHL only [rs=-0.27 P=0.046 N=40]. Similarly, age is correlated to LSTS [rs = - 0.349 P = 0.014 N = 40] and RSTS [rs = - 0.349 P = 0.014 N = 40]. Age is correlated with HD [rs = - 0.351 P = 0.013 N = 40]. Specifically, only age of worker [$\chi 2$ (1, N=40) = 5.840, p = 0.016] was showing significant relationship with prevalence of hearing disorder.

4.0 DISCUSSION

Workers working in mold manufacturing are exposed to loud noise from multiple sources such as CNC machine, surface grinding machine, air blower, pressurized air gun and gun wrench. Regulation 6 OSH (Noise Exposure) Regulation 2019 had stipulated that employer shall take necessary intervention in the form of engineering control and administrative control to reduce employee exposure to excessive noise above noise exposure limit (L_{EX}>85dBA, L_{MAX}>115dBA or L_{PEAK}>140dBC). As presented in Table IV, most of workers were exposed with excessive noise with > L_{EX} 42.5%, > L_{MAX} 32.5% and >L_{PEAK} 70%. Currently, the organization had provided an ear plug to all mold manufacturing workers working in high noise area. It had been observed that all the workers were wearing ear plug while working. Prevalence of hearing disorder among the mold manufacturing workers shows that many of the workers were having hearing disorder and surprisingly at young age. Results of this study failed to prove hypothesis that there is significant relationship between socio-demographic, occupational information, lifestyle of mold manufacturing workers against the number of workers with hearing disorder. Only age of workers found to have significant relationship with hearing disorder. Prevalence of hearing disorder was not showing significant relationship with L_{MAX} and L_{PEAK} except for L_{EX} was showing significant relationship with right ear hearing loss (RHL). This result cannot be validated with (13) findings who had mentioned that a person with right-handedness may be more likely to leave left ear turned towards a noise source from machine engine. Nevertheless,

this information regarding right handedness or left handedness of mold manufacturing worker was not collected during this study and should be included into future study.

Table IV was showing age have significant relationship with LHL, RHL, LSTS, RSTS and HD. The results were similarly found by Saber et al [14] who had observed statistically significant relationship between binaural hearing impairment and age. Kaerlev et al [15] mentioned that a Croatian study from 1996 demonstrated correlation between age, exposure, and the mean of hearing loss at 4000Hz. Besides that, Seidman et al. [19] had proved that age had significant effect of hearing loss ($P<0.04$).

However, it was peculiar to see that presbycusis was identified in this study among respondent ≤30 years old. Previous references [16] and [17] said that presbycusis is typically due to old age among those above 50 years old. Specifically, in this study, there was no notch signifying NIHL rather HD was characterized by HL at 4kHz, 6kHz and 8kHz with progressive deterioration of hearing threshold.

Based on the review of audiogram of 40 mold manufacturing workers, none was showing NIHL pattern which notches at 4kHz and recovery at 8KHz. However, pattern of audiogram in this study were showing presbycusis for workers ≤30 years. Arvin et al. [18] had revealed that age hearing loss (presbycusis) appears much clearer if the high frequency (above 8kHz) been taken into consideration. It can appear as early as 2nd decade (16%) and 3rd decade (50%). Industry Code of Practice for Management of Occupational Noise Exposure and Hearing Conservation 2019 had been requiring the organizations to conduct audiometric evaluating 0.5kHz to 8kHz which is different from previous practice of audiometric evaluation 0.5kHz to 6kHz which was required by Factory Machinery Act (Noise Regulation) 1989.

Further probing, several workers reported potentially and significantly confounding factors such as previous head injury in an accident, exposure to noise from previous workplace without wearing PHP, listening to loud music, hobby - diving to collect pearl, exposed to loud motorcycle exhaust noise, hypertension disease and accumulation of ear wax at both ears.

The main limitation of this study is small sample size as noise is unique to this workplace. Smaller sample size may reduce the power of study and increase the margin of error which need to be

improved in near future study. There were only 40 workers in high noise area considering this is an SME. Workers in mold manufacturing were wearing personal hearing protection (PHP) during the 8-hour shift. This study cannot establish the work-relatedness with prevalence of hearing disorder among mold manufacturing workers considering the study design – cross-sectional study.

5.0 CONCLUSION

It can be concluded that only age and L_{EX} of the mold manufacturing workers is associated with prevalence of hearing disorder among mold manufacturing workers. Hearing disorder experience by mold manufacturing does not seem to be work related. Further research or investigation should be carried out to consider non-occupational factors which may affect the worker's hearing threshold. However, management still needs to take effective intervention action to reduce L_{EX}, L_{MAX} and L_{PEAK} below permissible exposure limit that been set by OSH (Noise Exposure) Regulation 2019 instead of depending solely on usage of personal hearing protection only.

6.0 ACKNOWLEDGEMENTS

This study was supported by Open University Malaysia (OUM). We would like to express our gratitude to all respondents who took part in this research.

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LIST OF SYMBOLS

L_{EX} - Daily Noise Level

L_{MAX} - Maximum Noise Exposure Level

L_{PEAK} - Peak Noise Level

RHI – Right Ear Hearing Impairment

LHI -Left Ear Hearing Impairment

LHL- Left Ear Hearing Loss

RHL – Right Ear Hearing Loss

RSTS- Right Ear Standard Threshold Shift

LSTS – Left Ear Standard Threshold Shift

HD – Hearing Disorder

PHP – Personal Hearing Protection

NEL – Noise Exposure Limit

DOSH – Department of Occupational Safety and Health

ONRHD- Occupational Noise Related Hearing Disorder

ONIHL – Occupational Noise Induced Hearing Loss

SPSS- Statistical Package for the Social Science

CNC – Computerized Numerical Control

IV – Independent Variable

DV- Dependant Variable