

Original research article

A Cross Sectional Study on Noise-induced Hearing Loss in Heavy Machinery Workers

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Abstract

Introduction: Noise-induced hearing loss results from accumulated repetitive noise exposure of high amplitude. Heavy machinery workers are exposed to a noisy motorized machine that is carried on their back. We studied the prevalence of noise-induced hearing loss and its characteristics among the workers.

Materials and Methods: A comparative cross sectional study was conducted in Param ENT Hospital from (Dec 2011 to Jun 2017) on a group of Heavy machinery workers. Ear examination was conducted, followed by pure tone audiometry in a soundproof room at least 48 h after the subjects were free from the noise exposure. Noise-induced hearing loss was defined as failed definitive threshold at frequencies 3, 4 or 6 kHz of more than 20 dB with the loss at the two nearest frequencies on both sides of the dip amounting to at least 5 dB less. The intensity levels of the heavy machinery were measured by using a sound level meter by putting the probe near the external ear of the worker about 12 cm apart from his pinna.

Results: A total of 75 heavy machinery workers and a similar number of clerks participated in this study. The range of noise level of the machines was in between 91.3 dB and 100.7 dB with the mean of 95.0 dB. There was a significant correlation of noise-induced hearing loss in the heavy machinery workers (p value = .010) with the prevalence of 82.6%. The dip in PTA at 3, 4 and 6 kHz significantly occurred in the subjects with the p value of 0.001, 0.009 and 0.036 respectively.

Conclusion: It is warranted to give continuing education on the heavy machinery workers about the risk and how to protect them from noise-induced hearing loss. While the diagnosis should be made in the presence of exposure, the possibility of noise-induced hearing loss is highest when the dip occurs at 3 kHz followed by 4 and 6 kHz.

Keywords: ENT, PTA, Heavy machinery

Introduction

Noise-induced hearing loss (NIHL) or occupational hearing loss is defined as a permanent sensory neural hearing loss results from accumulated repetitive noise exposure of high amplitude.¹ This problem is highly prevalent among industrial community where the workers are exposed to variable degrees of noise. NIHL is a vital cause of disability and a tangible cost to society.^{2,3} It has been found to be the second most reported occupational disease and injury.^{4,5} According to the Department of

Occupational Safety and Health, Ministry of Human Resources Malaysia, the statistics for 1995–2009 showed that NIHL was the most commonly notified occupational disease and it is on an increasing trend.⁶ NIHL has been previously studied in certain workers such as construction workers, disc jockeys, orthopedic staff and oral healthcare providers.^{4,7–9} In Malaysia, the hearing loss was reported to occur among navy divers, vector control workers, airport workers and quarry workers.^{10–13} The rate of growth of grass in Malaysia, which is fast and consistent as a tropical area, has made a heavy machinery job in a great demand in order to maintain the neatness and to keep the beauty nature of the landscapes. Using heavy machinery is the best way for cutting long grass along the roadside and general agricultural land due to different levels and difficult angles that the grass can grow. The use of a lawn mower is not practical because the design of these machines is for use on the ground. Heavy machinery is a motorized cutter powered by petrol engine carried on the back by the workers and fixed with belts. This makes the heavy machinery exposed to a noisy job and has the risk of having NIHL. Noises produced by these machines are of two sources i.e. the one from the motor of the machine and the other is the sound results from the plastic string that breaks out the plants.¹⁴

Materials and Methods

A comparative cross sectional study was conducted in Param ENT Hospital from (Dec 2011 to Jun 2017) Those workers with a past history of head injury, having chronic ear diseases and history of current or past ototoxic medication intake were excluded from the study. The clerks of the same institution were chosen as they were not exposed to noisy environment. The sample size was calculated using a single proportion formula based on the prevalence of NIHL in pilot at 19%.¹⁶ The level of confidence was set at 95% and precision at 10%. After considering 20% dropout during the follow up, 71 heavy machinery were needed in this study where they were chosen by using simple random sampling. Ear examination was conducted, followed by pure tone audiometry (PTA) (A321 Twin Channel, Italy) in a sound treated room. PTA was done at least 48 h after the subjects were free from noise exposure to avoid recording asymptomatic threshold level. According to Melnick, recovery from asymptomatic threshold shift can be delayed and requires as much as 48 h to return to pre-exposure hearing levels from threshold shifts in 10 dB range.¹⁷ Noise-induced hearing loss was defined as failed definitive threshold at frequencies 3, 4 or 6 kHz of more than 20 dB with recovery at 8 kHz.^{18,19} The intensity levels of the heavy machinery were measured by using a sound level meter (Quest 2900, USA) during the procedure itself. The recording was done by putting the probe near the external ear of the worker about 12 cm apart from his pinna for 30 s. SPSS version 12 (SPSS Inc, Chicago, IL, USA) statistical software was used for data entry and analysis. The prevalence of NIHL was determined at 95% confidence interval (CI). The chi-square test (χ^2) was used to determine the association between heavy machinery and NIHL, as well as the comparison of NIHL at 3, 4 and 6 kHz between exposed and control group. The p-value was set at $p = .05$.

Result

A total of 75 heavy machinery workers participated in this study. The mean age was 38.9, and the range was between 20 to 53 years old. The mean duration of their working time in heavy machinery was 11.9 (SD 9.04) years. For the non-exposed group, similar number of clerks participated in this study. Their ages were ranged between 21 and 54 years old with the mean of 39.9. The mean duration of their

working time was 16.5 years. The range of noise level of the machines was in between 91.3 dBA and 100.7 dBA with the mean of 95.0 dBA.

Table 1: shows the relation between the grass-trimming job and the NIHL. There were 62 out of 75 (82.6%) subjects had NIHL, as determined by the characteristic dipping of PTA at 3, 4 and 6 kHz. There was statistically significant correlation of NIHL in the grass-trimming workers (p value = .010).

Group	Hearing status		x ² statistic (df)	p-value
	Normal hearing n (%)	NIHL n (%)		
Exposed	13 (8.7)	62 (41.3)	6.68 (1)	0.010
Non-exposed	27 (18.0)	48 (32.0)		

Table 2: shows the comparison of the dip PTA between the exposed and non-exposed group at 3, 4 and 6 kHz. The dips significantly occurred in the test group with the p value of .001, .009 and 036 respectively.

The comparison of NIHL at 3, 4 and 6 kHz between test and control group.

Hearing status notch	Test groupn (%)	Control groupn (%)	x ² statistic (df)	p-value
3 kHz				
No notch	40 (26.7)	60 (40.0)	12.00 (1)	0.001
Notched	35 (23.3)	15(10.0)		
4 kHz				
No notch	31(20.7)	47(31.3)	6.83 (1)	0.009
Notched	44(29.3)	28(18.7)		
6 kHz				
No notch	18(12.0)	30(20.0)	4.41 (1)	0.036
Notched	57(38.0)	45(30.0)		

Table 3: shows the mean hearing threshold of the subjects at each frequency tested. The hearing threshold at 3, 4, 6 and 8 kHz were below 20 dB with the lowest at 6 kHz.

Frequency	Mean (SD) (dB)
0.5 kHz	20.3 (10.0)
1 kHz	18.6 (10.2)
2 kHz	19.3 (11.3)
3 kHz	22.3 (12.4)
4 kHz	25.8 (15.9)
6 kHz	31.8 (17.4)
8 kHz	30.4 (20.1)

Discussion

Noise is a term that describes the sounds that are unpleasant or disagreeable. In otology it is known as the sound that causes either temporarily or permanent damage to the

inner ear. In our study, the noise intensity of the grass-trimming machine was ranging between 91.3 dBA and 100.7 dBA with the mean of 95.0 dBA. According to NIOSH safety guidelines, exposure to 95.0 dBA noise intensity without any hearing protection device should not be more than 47 min.²⁰ Our candidates mentioned that they worked at least 30 min to 1 h and had time for rest around 30 min to 1 h before continuing. In a typical day, they worked for about 5 h per day. In addition to that, they did not use any protective hearing device except goggles and a headdress lumbar to protect their eyes and hair respectively from the volatile fragments of grass. Therefore they were at risk toward the hazardous effect of the noise. The grass trimmers accelerate the engine when the bush is tall and abundant while when it is sprinkled and short they decelerate the machine. Therefore, the noise exposure is fluctuated. The present study showed a significant association between the grass-trimming workers and NIHL. In other words, the heavy machinery workers job carries hazard for the hearing and contributes to NIHL if no pre-cautions taken. Long-term exposure to daily noise levels above the subordinate action level of 80 dBA may ultimately ground for NIHL. According to Bauer et al., the disease process develops gradually over many years and is supposed to be prominent after 3–5 years as a minimum range.¹ Classically, the first sign of NIHL is a notching of the audiogram at 3, 4 or 6 kHz, with a recovery at 8 kHz. This audiometric notch deepens and progressively develops towards the lower frequencies when noise exposure continues.^{19,21} The finding of significant association between the notches and the heavy machinery workers in this study support the statement. The most significant associations occurred at 3 kHz followed by 4 and 6 kHz. However, it should be highlighted that the notching also occurred in the control group. Therefore, the use of audiogram pattern in confirming NIHL should be accompanied with an accurate history of exposure to noise. The findings may also cause by the noise exposure due to recreational or non occupational activities which is termed socioacusis. In the present study, the highest incidence of notch occurred at 6 kHz followed by 4 and then 3 kHz. The incidence of the dip depends upon the frequency and the intensity of the noise and duration of the exposure, which depends upon the noise produced by the machine itself. In addition to that, many of our participants aged below 30 years with working time of less than 5 years which is considered as short duration. McBride and Williams stated that the 4 kHz notch needs more time to be present as a sign of noise exposure.²² Studies done among those involved in music supported the opinion.^{23,24} It could be an early change in young subjects who were exposed to a broad band noise for 1–2 years, and when exposure continued up to 2–5 years the notch slid to 4 kHz. However, there is a controversy regarding the 6 kHz notch as a sign of NIHL. Coles et al. mentioned that it is a common finding when doing the pure tone audiometry using the headset TDH-39.²⁵ For that reason, by taking into account the calibration artifact associated with the usage of the earphones, they proposed that the results to be subtracted by 6 dB from the measured HTL values at 6 kHz as a corrective value. Raynal et al. observed a notch at 6 kHz in their study on French pilots aged 20–40 years old despite wearing the hearing protectors.¹⁶ They concluded that the 6 kHz notch represented regular exposure to broad band frequencies of continuous noise. Nevertheless, we found a significant association between the 6 kHz notch and NIHL. As far as the hearing level at each frequency is concerned, with the exception of 8 kHz, which is usually involved in presbycusis, hearing loss of more than 20 dB occurs at the frequencies of 3, 4 and 6 kHz but not at the lower frequencies. The findings further support the connection between these three frequencies and NIHL in grass-trimming workers.

Conclusion

Heavy machinery workers have a high risk of getting noise-induced hearing loss. Continuing education about the risk and how to protect themselves from hearing loss is therefore warranted. While the diagnosis should be made in the presence of exposure, the possibility of noise-induced hearing loss is highest when the dip occurs at 3 kHz followed by 4 and 6 kHz.

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