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ASSOCIATION BETWEEN NOISE INDUCED HEARING LOSS AND INTENSITY OF NOISE EXPOSURE IN INDUSTRY WORKERS

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ABSTRACT

Introduction : Long term exposure to noise at work causes hearing loss. Counter measures have reduced noise levels in many industries, but noise still remains a common occupational hazard, and noise induced hearing loss is one of the major occupational diseases worldwide. With this background the present study was undertaken to find out association between noise induced hearing loss (NIHL) and intensity of noise exposure in industry workers .

Methodology: The intensity of noise production in dBA units was noted in different industrial sections using a sound level meter. Pure tone audiometry was performed in 110 industrial workers, of which 70 workers belonged to high intensity noise exposure group and 40 workers belonged to unexposed office group. Air conduction and bone conduction for each ear were noted. The diagnosis of noise induced hearing loss was based on full evaluation of history, physical examination and audiometry. An employee was considered as having hearing impairment if his average of the hearing thresholds for frequencies 500Hz, 1000Hz, 2000 Hz and 4000 Hz, exceeded 25 dB. Analysis was done using Chi square test and T test.

Results: Noise induced hearing loss was found to be significantly higher in the exposed group as compared to unexposed group [P<0.0001]. All the 28 workers had a bilateral noise induced hearing loss.

Conclusion: By comparing the exposed group and the unexposed group, the present study concludes that as the intensity of noise exposure increases, noise induced hearing loss increases significantly. Beginning and progression of NIHL can be prevented by limiting noise exposure.

KEYWORDS :

Introduction:

Long term exposure to noise at work causes hearing loss. Although countermeasures have successfully reduced noise levels in many industries, noise is still a common occupational hazard, and noise induced hearing loss is one of the major occupational diseases worldwide.

Noise remains a common environmental pollutant in industrial work places and has been a constant issue since the industrial revolution. Noise is a wrong sound in a wrong place at a wrong time. [1]Noise is any undesired sound and, by extension, noise is any unwanted disturbance within a useful frequency band. [2]

Noise induced hearing loss (NIHL) is an irreversible sensorineural hearing loss associated with excessive noise exposure. 52-60% of all industrial workers get exposed to noise level of 85 dB or more for 8 hours a day. [3]

Worldwide, 16% of the disabling hearing loss in adults is attributed to occupational noise, ranging from 7 to 21 % in the various sub regions.[4]

NIHL is an important public health priority because as populations live longer and industrialization spreads, NIHL will add substantially to the global burden of disability. [5,6]

As the damage caused by noise on hearing is of permanent nature, it carries paramount importance in early detection. Fortunately, the diagnostic aids for early detection are available today.

The 1976 amendment of the factories act includes noise induced hearing loss, among the list of notifiable diseases. [7]

Hence the purpose of present study is to find out association between hearing loss and intensity of noise exposure in industry workers.

Material and Methods:

Industries around an urban city were surveyed. Heavy engineering industry associated with high intensity noise production was chosen for the present study. The study was conducted from March 2008 to March 2009.The study protocol was approved by the local ethics committee. All the industrial workers were thoroughly interviewed by using a standard proforma.

Workers with no pre-employment history of hearing loss were included in the present study. Workers having history of any disease, local or systemic, that can affect hearing, presence of any otological disease that affects hearing, history of high blood pressure, history of treatment with ototoxic drugs, past history of ear trauma or head trauma, evidence of respiratory infection including common cold, positive family history of hearing loss, history of smoking, history of noise exposure in previous jobs were excluded from the study.

Some workers were excluded from the study on the basis of history. Remaining workers were then subjected to clinical examination at the E.N.T. department, of a city general hospital, to rule out any otological disease that can cause hearing loss. 110 male workers belonging to the age group of 22 to 54 years were thus selected for the present study and a written consent regarding participation in the study was taken from them.

The present study was of cross sectional type. The workers working in manufacturing section, assembly section and paint shop section were exposed continuously to excessive noisy working during their working hours. Workers concerned with clerical job in office were not exposed to high intensity of noise. Hence the workers were classified into

Group	High intensity noise exposure	Section
Exposed	Present	Manufacturing
		Assembly
		Paint shop
Unexposed	Absent	Office

Of the 110 male workers selected for the present study, 70 workers belonged to the exposed group and 40 workers belonged to the

unexposed group.

The ambient noise levels were measured in different sections of the industry on a weekly holiday and on a working day on a dBA scale by a digital sound level meter (AGRONIC 8928). The ambient noise levels were recorded in manufacturing section, assembly section, paint shop section and office section, first with no machine working and then with all machines working at four different times of the day namely: 9 am, 12 noon, 3 pm and 6 pm. The mean of these determinations was calculated. The aim of the time determinations was to ascertain if there were peak periods for noise levels in these places.

The workers in the exposed and unexposed groups were subjected to pure tone audiometry and air conduction and bone conduction for each ear were noted. An audiometer is an electronic instrument capable of producing pure tone sounds of different frequencies at variable intensities. Audiometry is a graphic recording of hearing quantitatively and qualitatively. [8]

Audiometric tests were carried out in a sound proof room in the E.N.T. department of a city general hospital with a diagnostic audiometer [Model: eda 3 N 3 mille, Elkon co. ltd.]. The normal test sound was pure tone pulses at standardized frequencies in the range of 125-8000 Hz and the normal presentation mode was monoaurally by means of a standardized type of earphone. Ascending method [modified Hughson-Westlake method] was used for recording.

After familiarization by presenting a clearly audible test tone, it was based on repeated ascents from inaudible to just audible stimuli in steps of 5 dB. As soon as the listener responded, the level was decreased by 10 dB and a new ascent was started. The hearing threshold level was the stimulus level at which the listener first gave three correct responses after three to five ascending series of stimuli. The first test frequency was 1000 Hz followed by the higher frequencies in rising order and finally the lower frequencies in falling order. Air conduction and bone conduction for both the ears were noted. [9]

The diagnosis of noise induced hearing loss was based on full evaluation of history, physical examination and audiometry. [2]

A worker was diagnosed as a case of noise induced hearing loss on the basis of a clear and prolonged history of exposure to excessive noise, no evidence of any other otological pathology and an audiogram showing a significant high tone hearing loss with classical notching at 4-6 kHz, with some recovery at 8 kHz. [10,11]

However, in exposed group workers with more duration of service, the notch broadened and the neighbouring frequencies were progressively affected. Thus with increasing exposure time to noise, NIHL was also detected at lower frequencies.

An employee was considered as having hearing impairment if his average of the hearing thresholds for frequencies 500Hz, 1000Hz, 2000 Hz and 4000 Hz, exceeded 25 dB. [5,6]

The collected data was entered into SPSS (Statistical package for social science) database for analysis. Analysis was done by SPSS software version 10 by using Chi square test and T test. Significance level was set at $P<0.05$ and considered as significant.

Results

Table 1: Range and mean ambient noise levels (dBA) in different sections of exposed group and unexposed group.

Condition	Exposed group (dBA)					Unexposed group (dBA)	
	Section			All sections			
	Manufacturing		Assembly		Paint shop		Office
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Background (with no machine working)	60-68	66	58-64	62	62-68	64	58-68	64	60-62	61
All machines working (on)	95-115	105	92-102	97	85-95	92	85-115	98	60-62	61

Noise levels were recorded from each section, first with no machine working and then with all the machines working.

Table 1 show that with no machine working, the mean ambient noise levels in manufacturing section, assembly section, paint shop section and office section were 66 dBA, 62 dBA, 64 dBA and 61 dBA respectively.

With all the machines working, the mean ambient noise levels in manufacturing section, assembly section, paint shop section and office section were 105 dBA, 97 dBA, 92 dBA and 61 dBA respectively.

With no machine working, mean ambient noise levels in exposed group and unexposed group were 64 dBA and 61 dBA respectively. With all the machines working, mean ambient noise levels in exposed group and unexposed group were 98 dBA and 61 dBA respectively.

Table 2: Group and section wise distribution of workers.

Group	Section	No of workers (%)
Exposed	Manufacturing	25 (22.73)
	Assembly	27 (24.55)
	Paint shop	18 (16.36)
	Total	70 (63.63)
Unexposed	Office	40 (36.36)
Total number of workers	110 (100)	

Table 2 show group wise and section wise distribution of workers. 25 workers from the manufacturing section, 27 workers from the assembly section and 18 workers from the paint shop section (total 70 workers) who were exposed to high intensity noise were included in the exposed group. 40 workers from the office were included in the unexposed group.

Table 3: No. of workers with noise induced hearing loss in exposed group and unexposed group.

Noise induced hearing loss	Exposed (%)	Unexposed (%)	Total (%)
Present	27 (24.55)	1 (0.91)	28 (25.45)
Absent	43 (39.09)	39 (35.45)	82 (74.75)
Total	70 (63.64)	40 (36.36)	110 (100)

$X^2 = 15.61, P<0.0001$

Table 3 show total number of workers with noise induced hearing loss in exposed group and unexposed group. 27 workers from the exposed group had noise induced hearing loss while only 1 worker from the unexposed group had noise induced hearing loss. Noise induced hearing loss was found to be significantly higher in the exposed group as compared to unexposed group [$P<0.0001$]. All the 28 workers had a bilateral noise induced hearing loss.

Table 4: Section wise distribution of workers with noise induced hearing loss in exposed group.

Noise induced hearing loss	Manufacturing section (%)	Assembly section (%)	Paint shop section (%)	Total (%)
Present	14 (20)	8 (11.43)	5 (7.14)	27 (38.57)
Absent	11 (15.71)	19 (27.14)	13 (18.57)	43 (61.43)
Total	25 (35.71)	27 (38.57)	18 (25.71)	70 (100)

$X^2 = 5, P>0.05$

Table 4 show section wise distribution of workers with noise induced hearing loss in exposed group.14 workers from the manufacturing section, 8 workers from assembly section and 5 workers from paint shop section had noise induced hearing loss. The association between noise induced hearing loss and different sections in exposed group was found to be statistically insignificant [P>0.05].

DISCUSSION

In the present study, the workers in the exposed group were continuously exposed to high intensity noise during an 8 hour shift. According to O'Reilly O et al., Narlawar UW et al. and various other workers continuous noise exposure over the years is more damaging than the interrupted exposure to noise which permits the ear to have a rest period. [2,3,13]

NIHL was significant higher in workers exposed to high intensity of noise. The findings of the present study are in agreement with findings of Bhattacharya SK et al., Mills JH et al. and various other workers. [14,15,16] However, Sanderson JT et al. in their study did not find any association between intensity of noise exposure and NIHL which according to them might be attributed to intermittency of work. [17] In the present study, only one person (0.91 %) from the unexposed group was having noise induced hearing loss. It might be due to the cumulative effect of social noise exposure termed as 'socioacusis' [18] and individual susceptibility to noise. [2] Some people seem to have 'hardy' ears while some ears are 'tender', with marked hearing loss after minimal exposure to noise and thus individual susceptibility to noise-induced hearing loss varies greatly. [17]

Noised induced hearing loss in all the 28 workers was bilateral and showed a similar pattern in both the ears. The findings of present study are in agreement with Alberti PW and Wilmot TJ who stated that in pure noise induced permanent threshold shift, thresholds must be equal in both ears. [2,19]

After excessive exposure to excessive noise several temporary or permanent impairments have been noted experimentally like direct mechanical destruction of hair cells, [2, 20] changes in the cochlear vascular system and metabolic exhaustion of cochlear cells. [21]

The apoptotic process may be involved in intense noise-induced hair cell death. [22]

Noise exposure may induce cochlear vasoconstriction, increase vascular permeability, and cause localized oedema which decreases cochlear blood flow. This may lead to hypoxia, acidosis, and highly reduced conditions. It predisposes to non-enzymatic nitric oxide formation which is toxic to cells. [20]

There are large numbers of studies that suggest that noise overexposure results in the increased production of reactive oxygen species (ROS) [4] and products of lipid peroxidation [23] which play a role in hair cell loss.

In the present study number of workers with NIHL in different sections of the exposed group was more where the intensity of noise exposure was higher (Table 1, Table 4). However the association between NIHL and different sections of exposed group was statistically insignificant which can be explained by less difference in the intensity of noise exposure in various sub sections. In the present study, exposed group workers were exposed to noise levels above 90 dBA in an 8 hour work shift and had a significant noise induced hearing loss.

In India occupational permissible exposure limit for 8 hours time weighted average is 90 dBA while the National Institute for Occupational Safety and Health recommends a sound level below 85 dBA for an 8 hour daily exposure. [6]

Improper use of hearing protective devices and non-existence of noise reduction measures might explain the high percentage of workers with NIHL in the exposed group, in the present study. Nilsson R et al., Savell JF et al. and various other workers have emphasized the importance of proper usage of hearing-protection devices. [19,24,25]

For reducing the risk of occupational NIHL, the present study recommends that noisy machinery should be replaced with quieter substitutes. Noise sources should be located away from hard walls or corners. Suitable noise enclosures or barriers should be constructed. Interior surfaces should be lined with sound absorbing materials. Increased hearing conservation programs should be established which must include noise measurement, noise abatement and administrative controls, periodic audiometric testing, hearing protection, recordkeeping and employee training. [26]

Compulsory intermittent rest periods should be given to the workers. Rest areas with noise levels below 90 dBA should be provided. [6]

According to a WHO report, National Programmes for prevention of noise-induced hearing loss should be established or strengthened in all countries and integrated with Primary Health Care (PHC). [5]

By comparing the exposed group and the unexposed group, the present study concludes that as the intensity of noise exposure increases, noise induced hearing loss increases significantly. Beginning and progression of NIHL can be prevented by limiting noise exposure.

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