



## EFFECT OF DURATION OF SERVICE ON OCCUPATIONAL NOISE INDUCED HEARING LOSS IN INDUSTRY WORKERS

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**ABSTRACT** 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. Hence the purpose of present study is to find out number of workers with noise induced hearing loss in an industry associated with high duration of exposure so that preventive measures can be advised.

**Material and Methods:** 110 male workers were selected for the present study. 70 workers were from the exposed group and 40 workers were from the unexposed group. All workers in the industry, with no pre-employment history of hearing loss were included in the present study. The ambient noise levels were recorded in manufacturing section, assembly section, paint shop section and office section. 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 :** The difference in the mean values of duration of service between exposed group and unexposed group was statistically insignificant. Majority of the workers had service duration of more than 10 years. The association between noise induced hearing loss and duration of service was found to be statistically significant in exposed group. The association between noise induced hearing loss and duration of service was found to be statistically insignificant in unexposed group.

**Conclusion :** Workers whose 8 hour TWA exposures exceed 100 dBA should wear double hearing protection. Compulsory intermittent rest periods should be given to the workers. Rest areas with noise levels below 90 dBA should be provided. 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.

## 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 induced hearing loss (NIHL) is an irreversible sensorineural hearing loss associated with excessive noise exposure. Noise in excess of 85 dBA in a work environment of an 8-h daily work regime predisposes workers to NIHL.<sup>[1]</sup> NIHL is usually bilateral and symmetrical, affecting higher frequencies (3 kHz, 4 kHz or 6 kHz) and subsequently lower frequencies (0.5 kHz, 1 kHz or 2 kHz).<sup>[2,3]</sup> Global estimates of the prevalence of disabling hearing loss from occupational exposure range from 7% to 21%.<sup>[5]</sup>

Noise is a wrong sound in a wrong place at a wrong time.<sup>[1]</sup> Noise is any undesired sound and, by extension, noise is any unwanted disturbance within a useful frequency band.<sup>[4]</sup> The term "Noise pollution" has been coined to signify the vast cacophony of sounds that are being produced in the modern life, leading to health hazards.<sup>[1]</sup> Noise induced hearing loss (NIHL) is a permanent sensorineural hearing impairment resulting from prolonged exposure to high levels of noise.<sup>[5]</sup>

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.<sup>[2,3]</sup>

Occupational noise induced hearing loss causes problems not only for the individuals concerned but also for their families and co-workers.<sup>[6,7,8]</sup>

High noise level may not only cause hearing impairment but the

unpleasant characteristics of noise may also be responsible for stress related disorders, anxiety, depression, somatic complaints, sickness absence from work, and an increased accident rate.<sup>[9]</sup>

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.

Lot of legislation has come into force in developed and developing countries, to curb the evil of noise. The 1976 amendment of the factories act includes noise induced hearing loss, among the list of notifiable diseases.<sup>[10]</sup>

Noise induced hearing loss is not treatable by any means, but it is definitely preventable which is the only way to counteract the evil of noise. Lack of regulation of permissible levels of noise exposure in this sector means that hearing protection will not be enforced and repeated exposure to high levels of noise from these machines is likely to lead to reduced hearing ability. The damage to the human ear by high levels of noise in the work place environment is dependent on the intensity of noise and duration of exposure to noise.<sup>[11]</sup> In the absence of local production of market mill machines with attenuated noise levels, the use of ear plugs and ear muffs during operations of these small-scale mills remains the only viable preventive measure for this occupational health hazard.

Hence the purpose of present study is to find out number of workers with noise induced hearing loss in an industry associated with high duration of exposure so that preventive measures can be advised.

### Material and Methods:

Industries around an urban city were surveyed. Heavy engineering industries are associated with noise production of high intensity. Hence such an industry 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. Workers in the industry were interviewed in the factory dispensary with a prior appointment. Workers were selected by certain inclusion and exclusion criteria.

The present study was of cross sectional type. The workers working in manufacturing section, assembly section and paint shop section were exposed continuously to noisy working environment 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 were from the exposed group and 40 workers were from the unexposed group.

All workers in the industry, 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.

The rationale for the long exclusion criteria was to minimize the influence of many confounding factors in the development of hearing impairment. All the industrial workers were thoroughly interviewed by using a standard proforma. 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. Thus 110 male workers who belonged to the age group of 22 to 54 years were finally selected for the present study. A written consent regarding participation in the study was taken from all the selected workers.

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 'Digital sound level meter'. 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.

Digital sound level meter- AGRONIC 8928 was used. It has a measuring range from 40 dB to 130 dB and measures minimum, maximum and real time values of sound levels. Its dimensions are 30 mm [H] x 72 mm [W] x 182 mm [D] and weighs 150 g. It has got LCD type of display with 12.5mm height.

The sound level meter was calibrated before each use. It was held away from the operator's body to prevent sound reflection. Care was taken to avoid blocking of the sound waves by removing the objects in between sound source and the sound level meter. While taking the reading workers position relative to the sound source was considered. The measurements, in dBA units, on the LCD display were noted.

Manufacturing section, assembly section and paint shop section together comprised the exposed group. It was observed that all the machines in these sections were working almost throughout the day. The factory works continuously round the clock in three shifts of eight hours each. Posting of a worker in a particular section was of permanent nature. The shifts of workers were changed in rotation at the interval of one month. Protective devices like apron, shoes, helmets, goggles, hand gloves, masks and ear muffs were provided to the workers in the exposed group.

Office section comprised the unexposed group. Office section was 100 meters away from the study group and it was not surrounded by any

other plant concerned with noise production. The workers working in office section were having a working schedule from 9 am to 5 pm.

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.<sup>[12]</sup>

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. 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 monaurally 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.<sup>[13]</sup>

The diagnosis of noise induced hearing loss was based on full evaluation of history, physical examination and audiometry.<sup>[4]</sup>

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.<sup>[14,15]</sup>

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.<sup>[2,3]</sup>

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: Comparison of duration of service in exposed group and unexposed group.**

Parameter	Exposed Mean $\pm$ SD (n=70)	Unexposed Mean $\pm$ SD (n=40)	t Value	P Value
Duration of service (Years)	12.26 $\pm$ 5.06	10.78 $\pm$ 5.73	1.36	>0.05

Table 1 shows comparison of duration of service in exposed group and unexposed group. The difference in the mean values of duration of service between exposed group and unexposed group was statistically insignificant [P>0.05]. That means exposed and unexposed groups were comparable with respect to the duration of the service.

**Table 2: Distribution of workers with respect to duration of service in exposed group and unexposed group.**

Duration (Years)	Exposed group (%)	Unexposed group (%)	Total workers (%)
1 – 5	8 (7.27)	9 (8.18)	17 (15.45)
6 – 10	15 (13.64)	10 (9.09)	25 (22.73)
11 – 15	22 (20)	9 (8.18)	31 (28.18)
16 – 20	25 (22.73)	12 (10.91)	37 (33.64)
Total	70 (63.64)	40 (36.36)	110 (100)

Table 2 shows the distribution of workers with respect to duration of service in exposed group and unexposed group. Majority of the workers had service duration of more than 10 years.

**Table 3: Number of workers with noise induced hearing loss with respect to duration of service in exposed group.**

Duration of service (Years)	Noise induced hearing loss		Total
	Present	Absent	
1 – 5	1	7	8
6 – 10	4	11	15
11 – 15	7	15	22
16 – 20	15	10	25
Total	27	43	70

$$\chi^2 = 8.46, P < 0.05$$

Table 3 shows number of workers with noise induced hearing loss with respect to duration of service in the exposed group. In exposed group, as the duration of service advanced, number of workers with noise induced hearing loss increased. The association between noise induced hearing loss and duration of service was found to be statistically significant in exposed group [ $P < 0.05$ ].

**Table 4: Number of workers with noise induced hearing loss with respect to duration of service in unexposed group.**

Duration of Service (Years)	Noise Induced Hearing Loss		Total
	Present	Absent	
1 – 5	0	9	9
6 – 10	0	10	10
11 – 15	1	8	9
16 – 20	0	12	12
Total	1	39	40

$$\chi^2 = 3.53, P > 0.05$$

Table 4 shows that only 1 worker from the unexposed group, having service duration between 11-15 years, had noise induced hearing loss. The association between noise induced hearing loss and duration of service was found to be statistically insignificant in unexposed group [ $P > 0.05$ ].

## Discussion:

According to Table 1, exposed group and unexposed group were comparable with respect to the duration of service. Referring to table 2 it was observed that majority of the workers in the present study had service duration of more than 10 years. Table 3 shows that the association between noise induced hearing loss and duration of service in the exposed group was statistically significant. Table 4 shows that the association between noise induced hearing loss and duration of service in the unexposed group was statistically insignificant. Thus, in the present study, as the duration of exposure to high intensity noise increased, the number of workers with NIHL increased significantly.

The findings of the present study are in agreement with observations of Gravendeel et al., Shakhathreh et al. and various other workers.<sup>[16,17,18,19,20]</sup> NIHL does not normally develop in less than 1.25 years.<sup>[14]</sup> As the exposure time to loud noise increases, more and more hair cells are destroyed and hearing loss is permanent. The longer you are exposed to a loud noise, the more damaging it may be.<sup>[5,14]</sup>

Long term noise induced hearing damage represents a gradual accumulation of noise microtrauma which leads to histological changes like the loss, first of outer hair cells, then inner hair cells and supporting cells, followed by degeneration of nerve fibers and the spiral ganglion.<sup>[16]</sup>

Lawrence M et al. & Schnieder EA noted that exposure to loud noise over a period of time, reduces cochlear blood flow which in turn diminishes the exchange rate of perilymph and reduces the oxygen supply to the sensory cells. The subsequent hypoxidosis of the organ of Corti may cause metabolic breakdown and on prolonged exposure, degeneration of sensory cells.<sup>[21]</sup>

According to Vosteen, long term noise induced hearing damage is the outcome of a slowly accumulating exhaustion of metabolites at the

cytochemical or enzymatic levels not involving direct gross tissue destruction. The biochemical changes eventually produce widespread hair cell destruction only indirectly.<sup>[16]</sup>

Noise induced hearing loss is entirely preventable but totally incurable. The prevention can be done by various rehabilitative manoeuvres and mechanical devices.

A hearing conservation program must include noise measurement, noise abatement and/or administrative controls, periodic audiometric testing, hearing protection, recordkeeping, and employee training. Workers whose 8 hour TWA exposures exceed 100 dBA should wear double hearing protection.<sup>[22]</sup> Compulsory intermittent rest periods should be given to the workers. Rest areas with noise levels below 90 dBA should be provided.<sup>[3]</sup> 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).<sup>[2]</sup>

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