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A study on the assessment of Noise Induced Hearing Loss among adult factory workers

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ABSTRACT

Introduction: Occupational Hearing Loss is one of the most common occupational diseases. Noise induced hearing loss (NIHL) is more common in less developed countries .It is getting worse over the years with continued occupational noise exposure and is irreversible, but could be prevented . It is the second most common form of acquired hearing loss. The purpose of our study was to assess occupational NIHL, as measured by Audiometric testing in nearby workers exposed to occupational noise in the construction industry. This study was also designed to assess hearing threshold levels among exposed patients and to compare them with the nonexposed control group and to evaluate other variables.

Methods: This study was carried out as a Prospective Cross Sectional study. 100 Construction workers working in small scale unorganised sctor were evaluated in Audiology Units. Inclusion Criteria included Construction workers above 20 years of age & within 50 years of age to avoid HL due to aging and minimum 3 years of Occupational Exposure. All subjects signed a written informed consent to participate in the study. Same number of workers working in Non Exposed Enviroment was also evaluated.

Results: We noted that there was no significant difference in age across exposed versus unexposed groups. The assessment of audiometric tests revealed a predominance of pathological audiograms) in the group of workers exposed to occupational noise compared to those who were unexposed. This difference was statistically significant.

Conclusion: Our results suggest that hearing protection for workers in noisy environments is the best measure and probably the only and most effective measure in preventing occupational deafness. Routine monitoring of noise levels and hearing status in certain populations should be included as part of a program effective hearing conservation, Audiological assessment including should be performed pre-employment to find out vulnerable patients for NIHL.

Keywords: Noise, Hearing Loss, NIHL, Construction Workers

INTRODUCTION

Loss of hearing affects life as well as employment, education and well being, and is therefore a challenge for an individual during their regular as well as his/her social life.

Adult-onset hearing loss is the fifteenth most serious health problem which leads to social isolation and to serious economic burden [1]. 16% of the disabling hearing loss in adults worldwide is due to

occupational noise, while in different sub-regions ranges from 7% to 21% [1]. Noise induced hearing loss (NIHL) is more common in less developed countries [1]. It is getting worse over the years with continued occupational noise exposure [2] and is irreversible [3], but could be prevented [4]. It is the second most common form of acquired hearing loss [5].

About 30 million workers are exposed to hazardous noise, with an additional nine million exposed to solvents and metals that put them at risk for hearing loss (HL). Occupational HL is one of the most common occupational diseases. In all, 49% of male miners have HL by the age of 50 years. By the age of 60 years, this number goes up to 70% [6]. This problem is faced by a large sector of the working force; worldwide, about 16% of the disabling HL in adults (over four millions) results from occupational noise [7]. HL due to chronic noise exposure or noise-induced hearing loss (NIHL) has been associated with industry for many years [8]. Most of the western countries have their own regulations and rules for the protection of workers in noise-producing factories [9]. The Occupational Safety and Health Administration (OSHA) describes standards for occupational noise exposure in articles 1910.95 and 1926.52 [10]. OSHA states that an employer must implement hearing conservation programs for employees, if the noise level of the workplace is equal to or above 85 dB(A) for an averaged 8-h time period [11].

Excessive noise causes community annoyance, elevated blood pressure, stress, sleeping difficulties, reduced performance and tinnitus [1]. The majority of adults suffering from NIHL belong to Asia, where NIHL is a serious health problem. Asian countries are developing/less developed and lack preventive and curative health services. There is lack of awareness of NIHL among workers, employers and health providers. This is the main barrier in prevention of NIHL in these countries [12].

OSHA also states that exposure to impulsive or impact noise should not exceed 140 dB sound pressure level (SPL) peak.

Hearing conservation programs in the workplace and in the general population seek to increase compliance and effectiveness of the hearing protection protocols through audiometric screening tests and education on the dangers of noise exposure.

Employees are required to wear hearing protection when it is identified that their 8-h time weighted average is above the exposure action value of 90 dB SPL. If subsequent monitoring shows that 85 dB SPL is not surpassed for an 8-h time weighted average, the employee is no longer required to wear hearing protection [13]

Occupational health diseases generally are difficult to diagnose early because they often have a long latency period [14]. Hence, it is important to monitor worker's hearing for early diagnosing and preventing NIHL through a program of hearing conservation [15].

The purpose of our study was to assess objective occupational NIHL, as measured by Audiometric testing, and determine its relation to subjective sensation of hearing loss as well as to auditory and vestibular symptoms in nearby workers exposed to occupational noise in the construction industry. In addition, we aimed to determine whether the use of hearing protection devices such as earplugs and earmuffs, alone or combined, offer a differential benefit to prevent NIHL in noise exposed workers.

This study was also designed to assess hearing threshold levels among exposed patients and to compare them with the nonexposed control group and to evaluate other variables.

METHEDOLOGY

This study was carried out as a Prospective Cross Sectional study which involved Prior Consent & was found to be within ethical standards.

100 Randomly selected Construction workers working in Small scale unorganized sector were evaluated in this study. Evaluation was performed in Audiology Units.

Inclusion Criteria included Construction workers above 20 years of age & within 50 years of age to avoid HL due to aging and minimum 3 years of Occupational Exposure. All subjects signed a written informed consent to participate in the study.

We excluded workers with a personal or family history of congenital deafness, prolonged exposure to ototoxic agents (e.g., antituberculosis agents,

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aminoglycoside antibiotics, carbon monoxide, lead, and benzene), a history of hypertension for more than 5 years with poor control or blood pressure values higher than 140/90 mgHg at the time of the assessment. Subjects with a history of poorly controlled diabetes mellitus, alcoholism, moderate or severe head trauma & those suffering from any Infections were also excluded

For each subject, data of audiometric tests were collected. We also applied a predesigned Interviewing questionnaire questionnaire with sociodemographic information, Occupational Exposure , smoking and alcohol habit, employment history, current noise exposure, hearing protection use, auditory-related symptoms (e.g., tinnitus, vertigo), and self-assessment of hearing loss apart from points of General Clinical & Local Examination.
Noise level detection was performed using audiometric Unit with available range of 30-130 dB, A and C frequency weighting. Display is with dB(A).

All patients were clinically examined (otoscopical examination). Those who had suggestive history of HL, such as diabetes, hypertension, and family history of HL or head trauma, were excluded from the study. Any pathology of middle or external ear, such as impacted wax or otitis media, was detected and treated first to avoid fallacies in audiological tests.

Tympanometry was performed in all patients & only patients with normal middle ear pressure were involved in this study.

Audiometric assessment by standard pure-tone audiometry, using Audiometer Orbiter 922, was performed by the audiology consultants; bone and air conduction for both ears were individually performed from 250 up to 8000 Hz. HL was categorized according to Clark [16] into the following:

(1) *Mild HL*: hearing threshold between 26 and 40 dB HL.

(2) *Moderate HL*: hearing threshold between 41 and 55 dB HL.

(3) *Moderately severe HL*: hearing threshold between 56 and 70 dB HL.

(4) *Severe HL*: hearing threshold between 71 and 90 dB HL.

(5) *Profound HL*: hearing threshold more than +90 dB HL.

100 workers exposed to occupational noise (mean age: 30.9 ± 10.3 years) in and around Raipur District were the study subjects. For comparison, we also recruited 100 subjects (mean age: 31.2 ± 11.4 years) who were not working in noisy environments. Subjects working in the construction industry were included in the exposed group, whereas those working in shops , Vendors , offices were included in the unexposed group. All subjects signed a written informed consent to participate in the study.

The self-assessment of hearing loss was also determined if the subjects answered affirmatively to three out of the five questions included in the questionnaire [17] Similar questionnaires have been used in other studies. [18] The questions cover the following areas:

1. Subjective hearing disturbance,
2. Difficulties in hearing in a crowd or in a noisy environment,
3. Need to ask others to repeat frequently during a conversation,
4. Need to turn the volume up of the TV higher than that others would prefer,
5. Trouble knowing where sounds are coming from.

Data was filled in Microsoft Excel & analysed using a computer software Epi Info version 6.2 (Atlanta, Georgia, USA) and SPSS (SPSS Inc., Chicago, Illinois, USA). Version 20. P value of 0.05 and less was considered as statistically significant. Results were presented in simple proportions and means (±SD). Chi-square test was also used. Comparison between the study and the control group was performed using the *t*-test for two independent means. Comparison among the subgroups of the study group was carried out using one-way analysis of variance test, and comparison for nonparametric data was carried out using the Fisher exact test.

RESULTS

100 Randomly selected construction workers exposed to occupational noise (mean age: 30.9 ± 10.3 years) in and around Raipur District were the study subjects. For comparison, there was 100 subjects

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(mean age: 31.2 ± 11.4 years) who were not working in noisy environments like shops , Vendors , offices were included in the unexposed group. All subjects signed a written informed consent to participate in the study.

We noted that there was no significant difference in age across exposed versus unexposed groups. The assessment of audiometric tests revealed a predominance of pathological audiograms (70%) in the group of workers exposed to occupational noise compared to those who were unexposed. This difference was statistically significant (*P* less than 0.05).

The relationship between auditory symptoms (e.g., tinnitus and vertigo) and the exposure to occupational noise was explored. The number of subjects exposed to noise reporting tinnitus (*n* = 10; 10%) was significantly higher compared to those who were unexposed (*n* = 1; 1 %) (*P* = 0.005). The incidence of vertigo in noise-exposed (*n* = 12; 12 %) and unexposed (*n* = 11; 11%) subjects showed no significant between-group difference (*P* = 0.124)

The analysis of reports obtained from the self-assessment of hearing loss, all noise unexposed workers reported no abnormality, while 8 % of workers exposed to occupational noise reported subjective hearing impairment (*P* = 0.001).

Workers exposed to noise had a mean of 12.2 ± 9.6 years of exposure. . Out of these workers, only 8 % used both personal protective devices, while 15% used only one of these devices. Rest of these workers exposed to occupational noise reported that they never used any kind of hearing protection.

We analyzed the relationship of noise-related factors and the results of the audiometric test (normal or pathological). We found that workers with pathological audiograms had significantly longer noise-exposure duration relative to those with normal audiograms (*t* = 3.99, *P* < 0.001). The vast majority of those who never used hearing protection measures had audiometric abnormalities (90 %) whereas in those using hearing protection there was a similar distribution of normal and pathological audiograms The difference in pathological audiograms between these groups (never vs regular use of protection) was statistically significant (*P* = 0.001). Logistic regression analysis was performed using audiometry (normal or pathological) in occupational noise-exposed group as the dependent variable. The nominal independent variables (predictors) that were entered into the logistic regression model were gender, hearing protection use, incidence of vertigo or tinnitus, and recreational noise exposure. Continuous independent variables were age, duration of noise exposure, number of cigarettes/day, and the daily amount of alcoholic beverages. This logistic regression model was found to be significant (Chi square = 60.79, df = 8; *P* < 0.001). The results of the regression analysis revealed that significant predictors of occupational hearing loss in workers exposed to noise were the use of hearing protection measures at work (*P* < 0.001) and the duration of noise exposure (*P* = 0.040).

DISCUSSION

In this study, we compared workers with high occupational noise exposure and those unexposed to identify whether symptoms commonly related to hearing disturbance (subjective sensation of hearing loss, tinnitus, and vertigo) as well as the use of hearing protection devices are indeed closely associated with objective hearing loss, as measured by audiometric test. We also aimed at determining predictive factors of NIHL after controlling for confounding variables such as age, and tobacco or alcohol consumption. We found that, as expected, workers exposed to occupational noise exhibit a significant increase in pathological audiograms, compared with unexposed individuals. Importantly, although subjective symptoms, including self-reported hearing impairment, and tinnitus were particularly present in workers exposed to occupational noise, only the lack of use of hearing protection measures and a long duration of noise exposure emerged as important predictors of NIHL.

It is well established that hearing loss is the most common problem associated with exposure to noise. [19] . The National Institute of Health, United States, reported that nearly 20 million workers were regularly exposed to noise, of which 50% (10 million) suffered some hearing damage of different severity. [20] A study conducted by Wu *et al.*, using a system of health surveillance for hearing loss in Taiwan, found a 58% incidence of hearing impairment among workers exposed to noise. [21]Other studies performing pathological

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audiometry have found that 53-78% of workers exposed to occupational noise have hearing impairment worldwide. ,[22],[23] In our study, we found a 70% of pathological audiograms in noisy working environments. This incidence is within the range of the literature. [24]

Various auditory-related tinnituses are thought to be associated with hearing impairment. In our study, tinnitus was significantly more frequent in noise-exposed workers than in unexposed workers, although its incidence was lower than expected. Other studies of workers exposed to noise indicate that tinnitus is mainly associated with advanced hearing loss due to occupational noise exposure, while the subjects in this study had mild-to-moderate hearing loss. [25],[26]Because the presence of self-reported tinnitus was assessed using a simple (yes/no) question, we cannot rule out that the way this question was formulated may have influenced the results. Vertigo, however, was found to have no significant difference between groups. Our results suggest that despite a relatively low frequency of these symptoms in workers exposed to occupational noise, tinnitus rather than vertigo might be related to NIHL. However, the regression model revealed no predictive value of these symptoms for the development of NIHL.

Hearing disorders are often associated with objective manifestations, such as audiometric abnormalities as well as with the subjective sensation of hearing loss. However, it is not clear whether subjective manifestations, particularly in individuals regularly exposed to noise, appear early or not, and if they represent a good indicator of an actual hearing impairment. This would significantly help in the prevention of occupational hearing loss. Although several studies on NIHL are based on subjective symptoms of self-reported hearing loss, there is growing evidence of the need for objective measures of hearing damage, such as audiometry, for early and reliable detection of hearing impairment attributable to the work environment, and thus avoid severe and irreparable damage to hearing. Kerr *et al*. studied hearing as perceived by the individual and audiometry in 147 construction workers and 150 farmers in order to promote actions that lead to a reduction of NIHL. The range of sensitivity of perceived hearing loss compared to audiometric damage suggesting that self-reported hearing loss is not consistent with an actual hearing loss measured by audiometry. The poor relationship between loss of perceived and actual audition found suggests that best practice in assessing this dimension of hearing requires the inclusion of audiometric examination as part of a prevention program hearing loss. [22] It is well-known that there is a causal association between occupational exposure to noise and a permanent hearing loss.Th e lack of use of hearing protection devices worsens hearing capacity of individuals exposed to noise. [22]

In our study, we evaluated the appropriate use of personal protective equipment in workers exposed to noise. In the noise exposed group, the majority of workers who did not use protective measures had pathological audiograms. Among those who used these measures, there was a similar distribution of normal and pathological audiometry. When analyzing the combined use of protective measures, it was demonstrated that it has greater efficiency than the isolated use of earplugs or earmuffs, as those using both devices.

Most studies agree that the use of hearing protection devices is a key factor for prevention of hearing loss due to occupational noise exposure, and only these devices, and to a lesser extent rehabilitation, can ensure good hearing health in workers exposed to this physical agent. There were a high number of workers who were reluctant to use hearing protection. To promote safety and health at work should be emphasized in the training of workers.

Taken together, these studies and our results suggest that hearing protection for workers in noisy environments are the best measure and probably the only and most effective measure in preventing occupational deafness, as it has proven to be the main factor for hearing preservation despite the existence of subtle damage to hair cells of the cochlea.

In conclusion, our findings support and extend the following notions:

1. Workers exposed to occupational noise are particularly prone HL
2. Auditory-related symptoms such as tinnitus are also associated to NIHL
3. Self-report hearing loss does not represent a good indicator of an early objective audiometric damage.

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Thus, routine monitoring of noise levels and hearing status in certain populations should be included as part of a program effective hearing conservation.

CONCLUSION

Our results suggest that hearing protection for workers in noisy environments is the best measure and probably the only and most effective measure in preventing occupational deafness. Routine monitoring of noise levels and hearing status in certain populations should be included as part of a program effective hearing conservation Audiological assessment including should be performed pre-employment to find out vulnerable patients for NIHL.

These findings can be used to plan future strategies for health education interventions in the community. There is a need to take immediate measures for prevention and control of NIHL. Awareness campaigns about the common causes, complications and correct practices are recommended. This study and its results are applicable to the geographical and socioeconomic status around our Medical Institute.

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Compliance with Ethical Standards

Conflict Of Interest – None

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