NOISE INDUCED HEARING LOSS IN BASRAH STEEL FACTORY WORKERS

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ABSTRACT

***Background*: Noise Induced Hearing Loss (NIHL) is irreversible sensorineural deafness in one or both ears which develops gradually due to chronic exposure to injurious noise in employement.**

***Objective*: To study the extent of hearing loss among steel factory workers as a result of their exposure to noise and to formulate an educational program for wearing a protective devices during the work.**

***Methods*: The study involved 121 subjects aged between 20-59 years. Fifty eight were working in Basrah steel factory as a case group and 63 were working in Basrah medical college as a control group, so (242 ears) were tested for pure tone using air conduction test audiometer. Each group was subdivided into two subgroups according to their ages.The ages of the first subgroup were ranging from 20 to 39 years and the ages of the second subgroup were 40-59 years.**

***Results*: In the subgroup 20-39 years, 93.8% of the workers had bilateral hearing loss, while only 17.3% from the control group had hearing loss, there is a significant difference between the two groups regarding hearing loss (P<0.001) and its severity (P<0.001).**

In the subgroup 40-59 years, all workers had bilateral hearing loss and only 40% of the control group had bilateral hearng loss.There is a significant difference regarding hearing loss (P<0.001) and its sevrity (P=0.001) between the two groups.

Comparing the two age groups (20-39 years & 40-59 years), in the workers there is no significant difference in hearing loss (P=0.429), but there is a significant difference regarding severity of hearing loss (P<0.001). While in the control group, there is no significant difference in hearing loss but a significant difference in severity of hearing loss(P=0.093 and P= 0.006) respectively.

INTRODUCTION

Noise induced hearing loss is irreversible sensorineural hearing loss as a result of chronic exposure to loud noise for long period.[1] The repeatedor sustained exposure to sound level of approximately 85 dB leads to degenarative changes of the hair cells (especially the outer hair cells) and associated nerve fibers which causes permanent threshold shift.[2] In Indonesia according to the Ministery of Manpower (1978), it is suggested that the maximal noise intensity level in working place is not more than 85dB. In addition, working time should not be more than 8 hours/day. NIHL has been known since the industrial revolution. Although NIHL is permanent, irreversible, and frequent, it is preventable by using noise protector or reduced noise exposure.[3] The first symptoms of NIHL is usually difficulty in hearing conservation against noisy background; he/she hears just a jumble of noise. Consonants seem to be lost first. Often he/she mentions intermittent high pitch ringing in the ears. By that time the damage measured by audiometry will be severe which shows loss of sound perception at high frequencies, first in the 4-5kHz range, progressing both in severity and into lower frequency range. As harmful noise exposure continues the commonly affected frequencies will broaden and worsen in severity and when hearing is reduced at 3kHz and below conservation is significantly interfered with.[4] The loss of sensitivity and clarity of high pitch sounds and inability to discriminate speech sounds particularly in the presence of background noise results in major communication difficultywhich results in substantial physical and psychological distress. This occurs by reducing the quality of life through limiting communication, entertainment and employment opportunities and place a substantial burden on their family and friends.[5] In addition, untreated hearing loss

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especially in elderly people produces social isolation and depression.[6] Factors that influence NIHL are age, heredity, systemic diseases, infection of middle ear, ototoxic drugs, race, fatigue and smoking.[4] Internationally, NIHL is recognized as a significant occupational health problem,[7] and the prevalence of hearing loss ranged from about 75% of the population in westren countries to 21% in developing countries.[8]

The occupations that are more susceptible to hearing loss are:

Agriculture, mining, construction, manufacturing, transportation, military, orchestra musiciance & orchestra conductors.[9]

OBJECTIVES

To study the extent of hearing loss among steel factory workers as a result of their exposure to noise and to formulate an educational program for wearing a protective devices during the work and to change the job of affected workers to help prevent more cases of industrial deafness.

SUBJECTS AND METHODS

This study was a comparative cross sectional study. It was done in the department of physiology *(in a silent standard room)/* College of Medicine/University of Basrah, during the period of 2002-2003. Sample consists of 121 male subjects, their ages range from 20-59 years. Fifty eight of them were working in Basrah steel factory (in a department consists of 900 male workers) for a duration of employment from 3-27 years continously, who were exposed to noise level exceeding 85dB (up to 110 dB) as measured in the year 1988,[10] and there are no reasones to be changed during the years 2002-2003, for 8 hours daily without the use of protective devices regularly, they attended the department of physiology for pulmonary function test, and sixty three (from a total of 216 malesubjects) were working in Basrah Medical College as a control group (the duration of employment was 3-25 years continuosly). The workers of Basrah steel factory were expected to be healthy at the time of employment as there was preemployment medical examination to select these workers,so any deterioration in their health in comparison with general population is likely to be due to the effect of work. Also we will attempt to re-examin them few years later. They were carefully examined and questioned to exclude those with previous hearing problems, hereditary ear diseases, chronic diseases like diebetes mellitus, hypertension and rheumatiod arthritis,[11-14] use of ototoxic or other drugs or previously working in noise induced area in other places, heavy smokers & alcohol drinkers. Workers with conductive deafness were also excluded from the study (by using Weber's and Rinne's tests). Case & controle groups were matched for age also. All subjets were tested for pure tone using air conduction audiometeric test to determine the hearing thresholds. Each subject was made to sit in a comfortable chair and was asked to put on the head phones (type AS 50 pure-tone audiometer) supplied by Labsco-Germany. The instrument provided push-botton switches for selection of pure tone signal frequencies of **0.25, 0.5, 1, 2, 3, 4, 5, 6, 7,** and 8 kHz in steps of 5 dB in the range of (-5 to 70 dB). The signal presented by the observer could be cancelled by push button switch by the subject as soon as he can hear the tone. Each tone was presented at least 3 times to determine its audibility for ascertaining the threshold. Audiometric tests were only made at least 16 hrs after the last exposure to noise to allow recovery from any temporary hearing threshold shifts.

Essentially, the ascending technique of the up 5, down 10 method of threshold exploration was followed. The audiometer was calibrated as per the recommendations of American National Standard Institution.[15] Zero reference level was used for all the tested frequencies.

The degree of hearing loss was assessed as follows: [16, 17]

Degree of hearing	bottom range of hearing
Normal hearing	**down to 20 dB**
Mild hearing loss	**21-40 dB**
Moderate hearing loss	**41-60 dB**
Severe hearing loss	**61- 90 dB**
Profound hearing loss	**above 90 dB**

Statistical analysis was perfomed using SPSS version 15 to examine the associat. Fisher's exact test, T-test, and Chi-square test were used.

RESULTS

The study included 58 male workers from Basrah steel factory as a case group (as most of the workers in the factory were males) and 63 male subjectes working in Basrah medical college as a control group (A total 242 ears were tested). Their age ranges from 20-59 years. The case and control groups were divided into two subgroups according to their ages. The first subgroup whose age ranges from 20-39 years consisted of 92 subjects. Fourty four subjects (47.8%) were belonging to the case group, and the mean of their age was (31.59 ± 4.28 years) and the mean of years of their employment was (6.77±2.64 years). Fourty eight subjects (52.2%) were belonging to the control group and the mean of their age was 29.50±6.65 years and the mean of years of their employment was (6.29±1.9 years). Statistical analysis using T-test showed no significant difference in the age & years of employment between the case and control groups (P=0.079, P=0.205) respectively. Most of the steel factory workers (93.31%) had hearing loss which was bilateral and symetrical (70.4% of them had mild and 22.72% had moderate hearing loss) and only 6.87% of the workers had normal ears. While most of the control group (81.2%) had normal ears and only (18.8%) had hearing loss which was of mild type (66.67% of them had bilateral and 33.33% had unilateral hearing loss). There is a significant difference regarding hearing loss (P<0.0001) and severity of hearing loss (P<0.0001) between case and control groups as shown in (Table-1).

Table 1. Distribution of subjectes according to hearing loss and severity of hearing loss in the individual aged (20- 39 years)

Diagnosis		Steel factory workers	Medical college workers	Total
Normal		3 6.87%	39 81.2%	42
Hearing loss	*Mild*	31 70.41%	9 18.8%	40
	Moderate	10 22.72%	0	10
	Severe	0	0	0
Total		***44(48.2%)***	***48(51.8%)***	***92***
Chi-Square value=52.883, df=2 , P<0.001				

The 2nd subgroup whose age ranged from (40-59 years) consisted of 29 subjects, fourteen (48.3%) were belonging to the case group and the mean of their age was (46±4.77 years) and the mean of years of their employment were (20.57±3.47 years). Fifteen (51.7%) were belonging to the control group and the mean of their ages was (47.5± 5.5 years) & the mean of

years of their employment was 20.133±3.02. Statistical analysis using t-test showed no significant difference in the age & years of employment between the case and control groups (P=0.411, & P=0.825) respectively. All the workers had bilateral hearing loss, one worker (7.1%) had mild, ten workers (71.4%) had moderate and three workers (21.4%) had sever hearing loss. Regarding the control group, only six out of fifteen (40%) had bilateral hearing loss (20% as mild and 20% as moderate hearing loss). There is a significant difference in hearing loss (P<0.0001) and severity of hearing loss (P=0.001) between the case and control groups as shown in (Table-2).

Table 2. Distribution of subjects according to hearing loss and its severity in the individuals aged 40-59years

Diagnosis		Steel factory workers	Medical college workers	Total
Normal		0	9 (60%)	9
Hearing loss	Mild	1 (7.1%)	3(20%)	4
	Moderate	10(71.4%)	3(20%)	13
	SevSever	3(21.4%)	0(0)	3
Total		14(48.3%)	15(51.7%)	29
Chi-Square value=16.755, df=3, P=0.001				

There was no significant difference (P=0.759) in hearing loss between the two age groups of workers, but there was a significant difference in severity of hearing loss (P=0.011) between them, as shown in (Table-3). There were also a significant difference regarding years of employment between them (P <0.0001).

Table 3. Distribution of hearing loss insteel factory workers (cases) according to age.

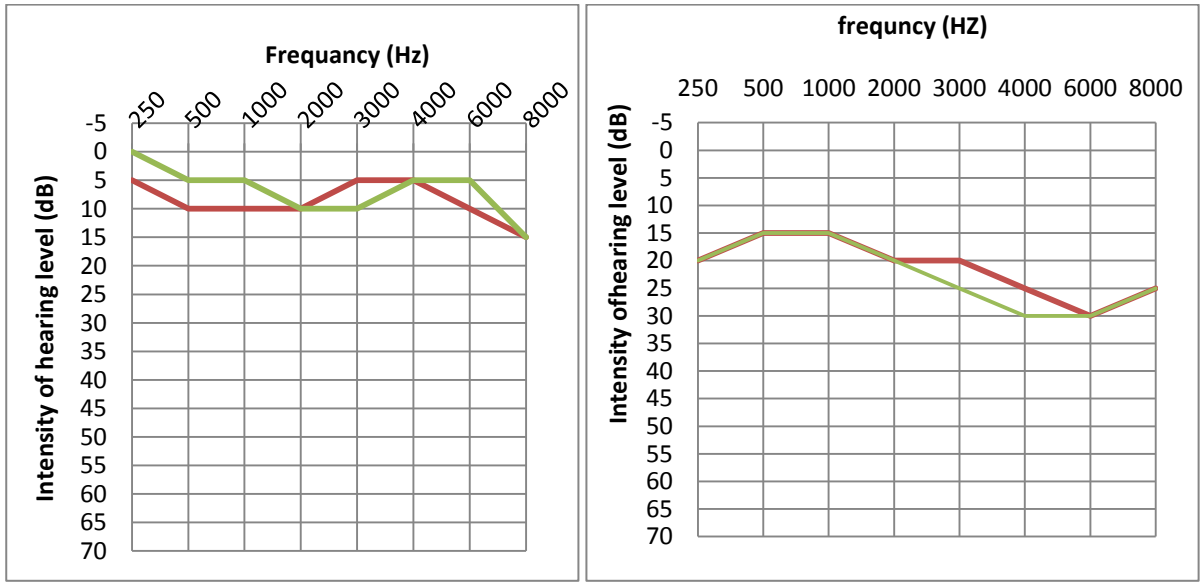
Age (years)	Hearing loss	
	+ve	-ve
20-39 (n=44)	41(93.2%)	3(6.87%)
40-59 (n=14)	14(100%)	0(0%)
Fisher, s Exact Test was applied, P=0.429		

While in the control group there was no significant difference regarding hearing loss but significant difference in severity of hearing loss (P=0.093, P=0.006 respectively between the two age groups) as shown in (Table-4).

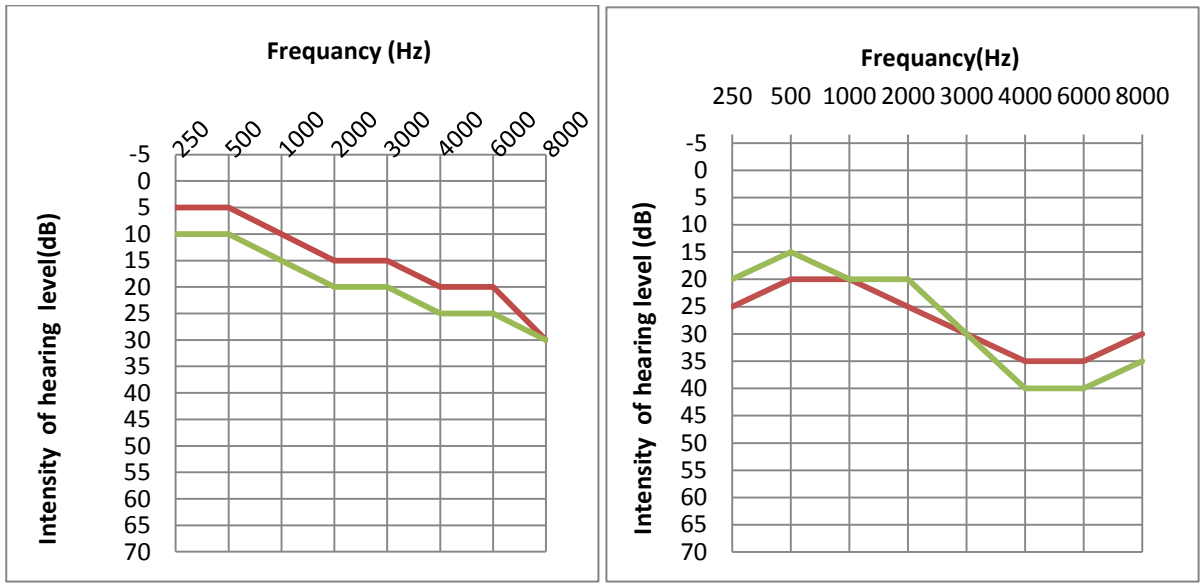
Table 4. Distribution of hearing loss among medical college workers according to age.

Age (years)	Hearing loss	
	+ve	-ve
20-39 (n=48)	9(18.8%)	39(81.3%)
40 -59 (n=15)	6(40%)	9(60%)
Fisher Exact Test was applied, P=0.093		

Audiogram pattern of hearing in the case and control groups is shown in (Figure-1).



Control **A** **Case**



Control **B** **Case**

Fig 1. Audiogram pattern of hearing in the 2 subgroups

A: In the subgroup20-39 years **B: In the subgroup 40-59 years**

Left ear **Right ear**

DISCUSSION

The results of this study revealed signifcant difference in hearing loss between workers and control group in the subgroup 20-39 years. As the workers and the control group are matched for age, years of employment with exclusion of diseases affecting hearing, so the difference between them is probably resulting from exposure of the workers to noise of electric furnas, and of the chemical reaction, which was more than 85 dB (up to 110 dB) for 8 hours daily without the use of ear protection devices regularly 93.13% of workers had bilateral hearing loss which was symetrical. This indicates bilateral and symetrical exposure to the noise which is in agreement with Ahmed et al 2001.[18] The other finding is that hearing loss predominantly affects frequenceis between (3-6 kHz) in different workers which is in line with Attias et al 2001[19] and Chen and Tsia 2003[9] with the maximum hearing loss (dip) localized at 4 kHz (as a mean threshold on group basis) as shown in Figure (1-A). Regarding hearing loss in the control group in those aged 20-39 years, which is only 18.8% (6 subjects had bilateral and 3 had unilateral hearing loss) and affects different frequencies from (3-8 kHz), This may be the result of exposure to certain noises like generator noises, or loud music. While the remaining 6.87% of the workers in this subgroup had normal ears. This might be attributed to individual susceptibility. One factor in this susceptibility is ABO blood group and Rh antigen[20] which needs further study in the future. There is also a signifcant difference regarding severity of hearing loss between the case and control groups ($P<0.001$), as all subjects with hearing loss in the control group had mild hearing loss, while hearing loss in the workers was of mild and moderate types. In the 2nd subgroup (age group 40-59 years), there is also a significant difference in hearing loss between the steel factory workers and control group ($P<0.001$). Forty percent of the control group had bilateral hearing loss (20% was of mild and 20% was of moderate type) which might be a result of the aging process (presbycusis), because thehearing ability decreased gradually from the age of 30s or 40s and progressively when we become older as a result of accumulation of many degenarative changes that are related to the aging process which mainly affects the cochlea and nerve pathway or due to zinc deficiency, or environmental conditions.[21] While in the case group all the workers had bilateral hearing loss (7.1% mild, 71.4% moderate and 21% severe hearing loss). Statistical analysis showed a signifcant difference regarding severity compared with the control group and this will indicate the additive effect of noise exposure and aging process as shown in Figure (1-B). The results also showed that there is no signifcant difference in hearing loss between the workers of the 2 age groups, but there is a signifcant difference regarding severity of hearing loss because of difference in the years of employement which was stastistically significant. There is also a signifcant difference in the severity of hearing loss between the two age subgroups of the control group, which might indicate the effect of aging process on hearing.

Conclusion, the study revealed that the steel factory workers included in this study are at high risk of developing hearing loss as a result of their excessive occupational exposure to noises which was more than 85 dB (up to 110 dB), without the regular use of ear protection devices in relation to the control group. The severity of hearing loss depends on the number of years of employment.We advise workers to wear protective devices during the working hours, at the same time they need regular audiometric tests and education to raise their awareness about the adverse effects of loud noise on their hearing.

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