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Original

An Investigation into the Effects of Hearing Loss and Hearing Impairment on Rebar Production Unit Workers of Kerman Steel Industries

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Abstract

Background: Acute hearing loss due to noise and hearing impairment is one of the most common occupational diseases which imposes significant direct and indirect costs on the government and exposed individuals. The steel industry is one of the industries that a great deal of noise is produced in different parts of its working process. Therefore, in this research, we tried to investigate the relationship between noise exposure and permanent hearing loss due to noise, as well as hearing impairment among employees of rebar production unit in Kerman Steel Industries. **Methods:** In this descriptive-analytic study, two methods of bioassay and environmental monitoring were used. In bioassay method, seventy one workers of the production line audiology condition, which was selected by census method, were tested and in the environmental monitoring, sound state of the production sector was measured and evaluated. Also, using a questionnaire, their personal information and work experience were recorded. **Results:** From the 71 workers surveyed, 20% were between 25-30 year old, 70% aged 30-40 years old, 10% were more than 40 years old, 63% had a work experience of 1-5 years and 37% had work experience more than 5 years. Comparison of the sound pressure level with the permissible national standard states showed that in 93% of the measured points, the sound pressure level was higher than standard, and the results of the audiometric data showed that in 55% of individuals, the hearing threshold in the right ear at a frequency of 4000 Hz has risen above 25 dB, and this value is 46% for the left ear. **Conclusion:** Considering that the increase in hearing thresholds at 4000 Hz is the main symptom of hearing loss due to working in industrial environments, we can conclude that taking control measures is very necessary. The percentage of auditory hearing impairment in the left, right and both ears is less than 10% and this can be attributed to the worker's work experience.

Keywords: NIHL; Audiometry; Hearing loss; Hearing impairment

Introduction

Noises are so irregular and unpleasant that exposure to them is usually inevitable and there is no definite relationship between the pressure ranges, frequencies and wavelengths.[1] In the present era, technological advances in all industrial fields, deployment, and application has been followed

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by a wide range of machinery and equipment; however, one of the biggest, most destructive and most important risks of industrialization and development of industries is the creation of undesirable sounds, that is, sound pollution and its unfavorable effects on life.[2] Some of the confirmed effects of exposure to noise include influence on blood pressure, performance, sleep disturbance, stress and anxiety as well as hearing loss.[3,4] Noise or unwanted sound is considered as one of the most important physical harmful factors in the working environment of the production units and has created a great number of problems for industrial workers. Thus, noise induced hearing loss is currently considered as one of the most common occupational diseases in industrialized countries.[5]

In many studies conducted on animals and humans, it has been found that exposure to persistent noise causes the destruction of intraocular hair cells. Long-term exposure to noise induces changes in blood pressure, immune system degradation, changes in levels of psychological stress and it is considered a serious risk for the development of the fetal hearing system.[6]

Moreover, noise can affect one's performance, particularly in works where mind is engaged. Therefore, noise has been taken seriously to increase work efficiency as well as reduce the effects of sound on the body in many countries.[7]

Recent studies have shown that high sound exposure from several seconds to hours may cause temporary hearing loss of sensory-nerve type, which often returns within 24 hours, and this is, in fact, a temporary hearing threshold change that is relevant to severity and the frequency of the sound, as well as the duration of exposure. In the event of repeated exposures to sounds that initially only caused a temporary change in the threshold of hearing, a permanent change in hearing threshold may occur, which is common in workers who deal with very high sounds. Hearing loss from frequent or repeated exposure to sound due to organic damage to courteous objects and cystic cells is a form of swelling in these cells, which, in the long run, will lead to permanent and non-reversible destructive damage of these cells, which means permanent deafness.[8] Wide studies on humans and animals have confirmed that exposure to persistent sounds causes NIHL to occur. NIHL is currently one of the most common occupational diseases in industrialized countries.[7,9,10] The results of many studies have shown that among different individuals, in terms of NIHL, when all are exposed to the same voice, there are differences, and some of the factors that make up this difference include the past exposure to ototoxic drugs, organic solvents and ,in addition, smoking, sex, skin color, age, and genetic structure.[11]

Workers in most industrial workshops are always exposed to persistent noise and periods of high intensity and fluctuation, and this exposure causes temporary and permanent loss of the hearing system, resulting in high costs on individuals and governments. For example, in a country such as the United States, this cost is estimated of about $1 million.[12] The need to address the noise problem and prevent hearing loss due to exposure is economically justifiable.[8] Fortunately, hearing loss can be prevented. Prevention of hearing loss by noise is as useful for employers as it is for workers to reduce their medical expenses and pay compensation to workers, so an effective hearing protection program seems to be necessary. Steel industry is one of the industries that creates a lot of noise in different parts of its working process and many workers in this industry are constantly exposed to it.[3,13-15]One of the goals of the experts in occupational health and medicine is assessing exposure levels and prioritizing the risk levels of exposure to harmful agents. Therefore, in this research, we tried to perform two environmental and biological monitoring of the exposure to noise in various units of the manufacture of rebar to screen and address the workers that are catching hearing loss so that an effective hearing protection program can be developed and implemented.

Methods

This study is an analytical, cross-sectional study that examines the permanent hearing loss caused by noise and hearing impairment among workers of rebar production unit in Kerman Steel Industries. Two methods of bioassay and environmental monitoring are used to do this work. In the environmental monitoring, a B&K sound meter was used which, after calibrating it at a frequency of 1000 Hz, measured the total sound pressure level in the frequency distribution network at desired points in the production hall. In the second method, the hearing condition of 71 workers of the census-selected production line was measured using the American Bell Tone device. Their personal information and work experience was recorded using a questionnaire. The criteria for workers for entering the study were absence of hearing impairment and non-use of cigarettes. Also, the entry of workers with a second job was prevented from the study. The method of audiometry was that all 71 workers were transferred to the acoustic chamber at the beginning of the shift and started to work. Also, using a pure sound and air method at frequencies of 250 to 8000 Hz, an auditory test was performed on them. Subsequently, based on existing relationships and eliminating the effect of age, the permanent loss of hearing from the sound was calculated at 4 frequencies of 500, 1000, 2000, and 4000 for both ears, and ultimately, the percentage of disability for the right ear, left and both ears were calculated simultaneously.[10,16]

Calculate the permanent loss of hearing caused by sound:

To determine the permanent loss of hearing caused by sound, the threshold of hearing in each of the 4 important frequencies 500, 1000, 2000, and 4000 is put into the following formula after omission of age effect and the rate of permanent hearing loss with the permanent hearing loss indicator caused by sound.

Equation 1:

$$NIHL=\{ (TL500HZ) + (TL1000HZ) + (TL2000HZ) + (TL4000HZ) /4\}$$

TL: Hearing threshold at the desired frequency in each duct (dB)

NIHL: Permanent hearing loss due to sound (dB)

With a permanent loss, you can determine the rate or percentage of disability in each ear based on the following method:

$$MI (\%) = (NIHL-25) \times 1.5$$

MI: The percentage of each ear's disability

The total disability percentage of both ears is calculated from the following equation:

Equation 2:

$$MI\ t= \{(MIb\times5) + (MIp\times1)\} / 6$$

MIt: Percentage of hearing impairment per person

MIb: The percentage of hearing disability in better ear

MIp: The percentage of disability in worse ear

Results

Of the 71 workers surveyed, 20% were between 25-30 years old and 70% were between 30-40 years old, 10% were older than 40 years old, 63% had a work experience of 1-5 years and 37% had more work experience than 5 years.

An environmental study showed that in 7% of the points of measurement of the pressure level was less than 85 dB, 70% of the points between 85 to 90 dB and 23% of the points of the sound pressure level was measured over 90 dB. On the other hand, individual monitoring (biomedicine) showed that the highest hearing loss was at a frequency of 4,000 Hz, while decreasing toward lower frequencies. The average hearing threshold at frequencies of 4000 and 6000 is above 25 dB, which in the left ear is 29.29 and 12.25 dB, respectively, and in the right ear, it is 30.42 and 1.30 dB, respectively, and at lower central frequencies the hearing threshold was below this value (Tables 2). 9.34% of people had hearing loss in the right ear, 9.34% in the left ear and 7.7% in both ears simultaneously. For this percent of the subjects, the mean hearing loss of the left ear, right ear and both ears were 7%, 9.2% and 6%, respectively.

Table 1. Auditory threshold for subjects at the frequencies examined in the right ear

No	Central Frequency	Right ear				
		Over 25 dB	maximum	minimum	average	Standard deviation
1	250	%5	40	5	15.24	5.71
2	500	%7	40	5	15.10	5.13
3	1000	%5	45	0	16.22	6.12
4	2000	%4	30	0	11.30	9.10
5	3000	%23	35	10	11.60	10.48
6	4000	%55	80	10	30.42	15.48
7	6000	%48	75	10	30.10	15.26
8	8000	%33	65	15	25.86	12.24

Table 2. Auditory threshold for subjects at the frequencies examined in the left ear

No	Central Frequency	left ear				
		Over 25 dB	maximum	minimum	average	Standard deviation
1	250	%3	40	0	4.32	4.15
2	500	%4	35	0	7.81	7.39
3	1000	%3	40	0	8.11	7.10
4	2000	%5	30	0	7.29	6.62
5	3000	%28	45	5	11.85	11.54
6	40000	%46	65	15	29.30	16.30
7	6000	%35	65	10	25.12	17.77
8	8000	%26	50	10	18.40	19.93

Discussion

Comparing the levels of sound pressure with the national standard limits, it is shown that in 93% of the measured points, the sound pressure level is higher than the permissible 8 hours of work, 85 dB. Thus, it is expected that people working in these areas experience varying degrees of hearing loss during prolonged exposure.

The audiometric results of the individuals show that in 55% of the subjects the hearing threshold in the right ear increased at a frequency of 4000 Hz up to 25 dB, and this value for the left ear was 46%. Since the increase in the hearing threshold at a frequency of 4000 is one of the main symptoms of hearing loss due to work in industrial environments, we can conclude that taking control measures for workers in this industry is paramount. Studies by Nilsson et al. on hearing loss in the workforce of an industrial unit also revealed that sensory hearing impairment at 4 Hz was evident among individuals.[17]moreover, in a study by Kim and Hang, there was a significant relationship between occupational exposure to noise (sound intensity and work experience) and hearing impairment.[18]

The percentage of auditory hearing impairment in the left, right and both ears is less than 10%, which can be attributed to the worker's work experience (63% of workers with work experience between 1 and 5 years). However, based on a scientific and proven pattern, the onset of occupational hearing loss from low frequencies to bell frequencies is expected to result in hearing loss with a higher percentage at low frequencies and conversational suffering, with the frequency of exposure to noise. In this case, the percentage of relative frequency of hearing impaired people and their hearing impairment will increase.

The results of the Ferrite and Santana studies showed that there was a significant positive correlation between age and auditory loss with occupational exposure to noise and hearing impairment.[19]Therefore, in the view of the above results, and especially the high level of sound pressure in the work environment, and as 63% of workers in this factory have the work experience of less than 5 years, therefore, with a preventive program for hearing loss can be observed.

Conflict of interest

The authors declare no conflict of interest.

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