Noise Induced Hearing Loss among Workers of an Iranian Axial Parts Factory, 2009

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ABSTRACT

The aim of the present study was to examine the rate of noise induced hearing loss in a group of punching and cutting section and other occupational groups workers and its relation with sound pressure levels, age and work history. This descriptive, cross-sectional study included 245 workers of the punching and cutting section and other occupational groups of an Iranian Axial Parts Factory in 2009. Hearing threshold limits were measured in both ears at 250, 500, 1000, 2000, 4000 and 8000 Hz with AC40 clinical Audiometer. In addition, sound pressure levels measured with IEC 60651 sound level meter at dBA in 148 stations of workers task with NIOSH standard method. At places where the sound pressure levels were upper than 85 dBA, the frequency analysis was also done. The mean age of the population under study was 34.61 ± 8.76 years and mean work history was 11.74 ± 4.21 years. Equivalent sound level (Leq) was at least 98.1dBA and at the most 115.7dBA. In addition, result indicated NIHLt was ranged 17.45 to 56/67 dB. According to regression analysis, with assumption of a fixed work history, there is a mean decrease of 0.21 dB in NIHLt for every decibels of increase in equivalent sound level (Leq) and with assumption of a fixed equivalent sound level (Leq); there is a mean decrease of 0.42 dB in NIHLt for every year of increase in work history (p < 0.05). NIHL of varying degrees in workers of an Iranian Axial Parts Factory starts at 4000 Hz and is then directed towards upper or lower frequencies.

Keywords: Equivalent sound level, Noise induced hearing loss, Age, Work history, Iran

INTRODUCTION

With advances in technology and science and use of various machines and tools in the cycle of production leading to exposure of workers to hazardous factors, attention to the occupational health of workers is considered as the most important capital in industry [1, 2]. Noise is considered as the most prevalent and common hazardous factor in the work places all over the world such that approximately 600 million workers are at risk of exposure to noise due to work [1, 3]. When the noise levels exceed normal limits, it can lead to hazardous effects on various parts of the body like hearing loss, effect on blood circulation, psychological disorders, and decreased work output [4, 5]. According to WHO statistics, noise induced damages amount to approximately 4 million dollars per day [6-8]. Even though noise induced hearing loss (NIHL) is preventable, it is one of the most important problems of the industrial world and considered as one of the 10 major occupational diseases [9]. Hearing loss due to long-term exposure to noise leads to permanent disability [10, 11]. Noise induced hearing loss usually occurs over the initial 10-15 years at higher frequencies and usually starts at 4000 Hz but its rate is associated with various personal and environmental factors [12].

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Table 1. Results of Sound Pressure Levels measurements in different manufactories

<table>
<thead>
<tr>
<th>Work Tasks</th>
<th>Number of Workers with Noise Exposure</th>
<th>Manufactory Area (m²)</th>
<th>Number of SPL Measurement Stations</th>
<th>SPL Max (dBA)</th>
<th>SPL Min (dBA)</th>
<th>Number of Stations with SPL&lt;85 dBA</th>
<th>Number of Stations with SPL&gt;85 dBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Punching</td>
<td>114</td>
<td>1100</td>
<td>50</td>
<td>125.8</td>
<td>89.2</td>
<td>0</td>
<td>50</td>
</tr>
<tr>
<td>Cutting</td>
<td>98</td>
<td>1250</td>
<td>55</td>
<td>118.9</td>
<td>85.6</td>
<td>0</td>
<td>55</td>
</tr>
<tr>
<td>Others</td>
<td>33</td>
<td>1000</td>
<td>43</td>
<td>98.7</td>
<td>73.5</td>
<td>17</td>
<td>26</td>
</tr>
</tbody>
</table>

Noise induced hearing loss initially occurs at high frequencies (4, 6 kHz) and if it continues, involves other frequencies too [13, 14]. Therefore, audiometry has to be done in order to confirm the diagnosis of noise induced hearing loss [15]. Age and work history are two important factors in relation to noise induced hearing loss, both temporary (TTS) and permanent (PTS).

According to the classification by the National Standard Association and Ear, Nose and Throat Academy of the United States of America, fall of 25-40 dB negligible hearing loss, 40-55 dB soft hearing loss, 55-70 dB moderate hearing loss, 70-90 dB severe hearing loss and fall of more than 90 dB is considered as permanent hearing loss [15]. The minimum level of sound pressure that can cause temporary hearing loss is 65dB. Normally, the acceptable limit is exposure to 85 dB for daily 8 hours work and with every 3-5 dB increase, the time period of exposure should be halved [16]. Research shows that workers all over the world, especially in developing countries have hearing loss problems such that in Singapore, the most common occupational disease is noise induced hearing loss. From among the workers of Korea, Hong Kong, Singapore, and Philippines exposed to noise, 12, 15, 40 and 74 percent of the workers had hearing loss of more than 30 dB [17, 18]. Noise induced hearing loss is significantly more in workers of the punching and cutting industry [19].

This study was therefore done to investigate the effects of noise, age, work history on incidence of hearing loss in workers of an Iranian Axial Parts factory, and provide hearing preventive and safety programs.

**MATERIALS AND METHODS**

This descriptive cross-sectional study evaluated the state of hearing of all 245 workers of the punching and cutting sections and other occupational groups of Iran Khodro Axial Parts factory in 2009. The mean daily work hours of the population under study were 8 hours and 6 days a week. Sound pressure levels (SPL) measured with IEC 60651 sound level meter at dBA with impulse time weighting for punching workstations and slow time weighting for other work stations in 148 stations of workers task in hearing zone height with NIOSH standard method [20]. The calibration was done in frequency of 1000 Hz and sound pressure level of 94 dB, in the work place with standard method. At places where the sound pressure levels were upper than 85 dB, one octave band frequency analysis (63 Hz – 8000 Hz) in C frequency weighting was also done [21, 22]. Then with having sound pressure levels and determination of noise exposure patterns, the equivalent sound levels (Leq) were calculated for all workers.

The hearing threshold limits in different frequencies of left and right ears were measured by AC40 clinical Audiometer by the standard method in one of the occupational medicine clinic [6]. In order to achieve accurate results, audiometric tests were done at the beginning of the work shift with a minimum 12-hour interval after the previous noise exposure. Then permanent noise induced hearing loss of each left and right ears were calculated by the equation below:

$$NIHL_b = \frac{\left( TL_{\text{left ear}} \right) + \left( TL_{\text{right ear}} \right) + \left( TL_{\text{2000Hz}} \right) + \left( TL_{\text{4000Hz}} \right)}{4}$$

TL: Hearing Threshold Limits in different frequencies (dB)

NIHL: Permanent Noise Induced Hearing Loss (dB)

NIHL_b: Permanent Noise Induced Hearing Loss of ear with better hearing (dB)

NIHL_p: Permanent Noise Induced Hearing Loss of ear with poor hearing (dB)

It is worth mentioning that only a few workers used personal protective equipments like earplugs or earmuffs. Those with a ruptured eardrum or history of ear surgery due to illness or injury were excluded from the study. The wax of those workers with earwax was removed before performing audiometry.

After entering the data in SPSS V.17.0, evaluation was done by ANOVA statistical method and the means were compared by Less Significant Difference (LSD) statistical method. A P-value of 0.05 was considered as significant.

**RESULTS**

Of 245 workers under study, 114 (46.53%) were punching workers, 98 (40%) were cutting workers and 33 (13.47%) were workers of other occupational groups. According Table 1, maximum sound pressure level (SPL_max) was 125.8 dBA and belongs to punching
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Table 2. Different variables’ central indices distribution of workers of an Iranian Axial Parts Factory

<table>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (Years)</td>
<td>26</td>
<td>57</td>
<td>34.61</td>
<td>8.76</td>
</tr>
<tr>
<td>Work History (Years)</td>
<td>5</td>
<td>20</td>
<td>11.74</td>
<td>4.21</td>
</tr>
<tr>
<td>Leq (8 hr) (dBA)</td>
<td>98.1</td>
<td>115.7</td>
<td>101.8</td>
<td>3.35</td>
</tr>
</tbody>
</table>

manufactory and minimum sound pressure level (SPL_{min}) was 73.5 dBA which belongs to other occupational groups manufactory. In addition, all of the stations of punching and cutting manufactories had SPL>85 dBA. According to Table 2, the minimum, maximum and mean age of the workers and work history were 26, 57, 34.61 ± 8.76 years, and 5, 20 and 11.74 ± 4.21 years. The minimum, maximum and mean of A-weighted equivalent sound level (Leq) at the workplace were 98.1, 115.5 and 101.8 ± 3.35 dBA. As shown in Table 3, the minimum, maximum and mean NIHL of the right ear were 15, 50 and 27.31 ± 9.62 dB, while that of the left ear were 15, 45 and 25.67 ± 15.74 dB, respectively. Similarly, the minimum and maximum NIHL_{t} were 17.45 dB and 56.67 dB and the mean NIHL_{t} was 27.84 ± 11.08 dB. The one octave band frequency analysis (63 Hz – 8000 Hz) in 10 selected stations of different manufactories and the NIHL frequency analysis (250 Hz – 8000 Hz) of both ears were shown in Fig.1 and Fig.2. The results of Fig. 2 show that the rate of hearing loss at frequency of 4000 Hz was more than other frequencies.

In order to evaluate simultaneously the effects of variables like work history and equivalent sound level on degree of noise induced hearing loss, regression analysis was performed and the final regression line was calculated as follows:

\[ \text{NIHL}_{t} = (0.21 \times \text{Equivalent sound level}) + (\text{Work history} \times 0.42) \]

In this analysis, the coefficients of equivalent sound level (Leq) and work history were significant \((p < 0.05)\). Thus, as shown in the above equation, assuming the work history to be constant, there was a fall of 0.21 dB of NIHL_{t} for every decibel of increase in equivalent sound level (Leq). Similarly, assuming the equivalent sound level (Leq) to be constant, there was a fall of 0.42 dB of NIHL_{t} for every year of increase in work history. In other words, the effect of work history was more than
equivalent sound level (Leq) on noise induced hearing loss. Fig. 3 shows that with an increase in the rate of work history, the mean of the NIHL also increased in the population under study. Fig. 4 shows that mean decrease in NIHL was different in various work sections of the company, such that this rate was more in punching section than the cutting section and that in the cutting section was more than the other sections like tool manufacturing and packaging sections. Similarly, according to $t$-Test results, the effect of the rate of work history on increase in noise induced hearing loss was significant with a $p < 0.05$ and confidence of 95%.

**DISCUSSION**

To date, many studies about hearing loss in different industrial work places have been done in the world and Iran. The results of these studies show that noise induced hearing loss is significantly more in workers of the punching and cutting manufactories [26]. The results of Olera’s study on hearing thresholds in an auto assembly plant in a Nigerian factory have shown that NIHL among workers usually occurs at higher frequencies. Similarly, NIHL at frequency of 4000 Hz is more than that at 1000 and 2000 Hz [19]. Hearing loss in workplaces starts at 4000 Hz and is then directed towards higher and lower frequencies [15]. It was shown that in workplaces with high sound pressure levels, there was a meaningful relationship with increase in NIHL (OR = 4.25, CI = 95%, 1.28 – 14.1) and the rate of noise induced hearing loss at frequency of 4000 Hz was more than other frequencies [13].

According to the results of the present study, the rate of NIHL varied in workers of the punching and cutting sections of an Iranian Axial Parts factory. The relation between noise increased hearing loss and age and work
history in the present study is in line with the results of another study [27].

In the study by Hazrati in workers of door and window making industry of Ardabil, Iran, there was a meaningful relationship between mean daily work hours and noise induced hearing loss at frequencies of 2, 3, 4 and 8 kHz and correlation test confirmed the relationship between work history and NIHL [28].

In the study by Golmohammadi and co workers on steel rolling mill workers of Isfahan, the sound pressure levels at the workplace were between 75 – 105 dB, mean work history was 10.3 ± 3.5 years and mean age was 37.4 ± 6.7 years. The relationship between work history and noise induced hearing loss in the workers was direct, positive and linear like the workers of different manufactories of an Iranian Axial Parts factory [29]. This relationship was also observed in the study by Halvani and co workers on Clothing Mills workers of Yazd [30].

Following results of the study, we can conclude that regular medical examinations of workers in all industries are necessary. It is also needed to use personal protective equipments and to provide appropriate medical education of both workers and the management staff of said industries in order to prevent this kind of occupational disease [21]. Companies where more effort is put into hearing conservation program activities can achieve a greater positive impact on employee awareness. However, there were broad deficiencies even in the better programs in this sample, suggesting that workers in this industry probably face a continuing substantial risk of occupational hearing loss [32].

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REFERENCES

21. ACGIH. Threshold Limit Values (TLV) and Biological Exposure Index (BEI). American Conference of Governmental Industrial Hygienists., Cincinnati, 2005.