

ORIGINAL ARTICLE

Evaluation of Hearing Loss and Changes in Blood Pressure of Welders in a 4 Year Period

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ABSTRACT

Improvements in science and technology and the use of modern machinery in manufacture have led to increase in the number of workers exposed to hazardous agents including noise. This study evaluated the effects of occupational noise on hearing loss and blood pressure in welders after 4 years. In this cohort study, all of the welders working at one of Neyshabur's water heater producing factories were studied. A questionnaire including demographic data, history of diseases and certain drug use was completed for each worker. Moreover the workers audiometry results and blood pressure measurements from 4 years ago were compared with recent results. Data analysis was performed using SPSS18 software. The average age of the welders was of 35.6 ± 6.25 and the mean years of employment was 7.66 ± 2.18 years. The equivalent noise exposure of workers on one business day was 97.8 dB and varied between 90-110 dB. After 4 years, there was a significant increase in hearing loss (6.04 dB) in the right ear of workers at 8000 Hz ($p=0.0001$) and in the left ear at 1000 (1.77 dB) ($p=0.04$), 4000 (2.29 dB) ($p=0.02$) and 8000 Hz (4.89 dB) ($p=0.0001$). During this time blood pressure also increased but was not significant. There was no significant relation between age, years of employment, smoking and education with individual hearing loss during these four years. Many neglected job groups such as welders are prone to hearing loss and possibly chronic increases in blood pressure due to noise exposure in their workplace and should use protective hearing equipment.

Keywords: Noise, Hearing loss, Blood pressure, Welders

INTRODUCTION

Our world is full of noises. Noise production from different sources has increased in modern societies. Science and technology improvements and use of modern machinery in the production process has caused the number of workers exposed to hazardous agents including noise to increase dramatically [1]. Noise is

known to be the most prevalent hazardous factor in the workplace [2-5] which millions of workers are exposed to [6-7]. When noise exceeds its standard 85 dB limit (according to American Conference of Governmental Industrial Hygienists standards); it can have negative impact on different parts of the body. Some of its physiological effects are increase in blood pressure and heart rate, muscle contraction, contraction of superficial veins, dizziness, nausea, vomiting and increased secretion of catecholamines and cortisol [8-11].

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Its psychological effects include disturbance in sensory and cognitive processes, negative effects on productivity, attitudes and feelings, difficulty in reading and understanding, reduced brain activity, carelessness, and disturbances in sleep cycles [8, 11]. It has also been determined in many studies that workers exposed to noises are more vulnerable to risks [12-13].

Hearing loss and tinnitus are among the most important physiologic effects of noise exposure [8, 11, 13]. Noise induced hearing loss (NIHL) is the second leading cause of hearing loss after presbycusis and is among the 10 major occupational diseases in Canada and the United States [14]. Noise induced hearing loss depends on the individual's sensitivity, exposure duration, age, intensity and frequency of sound and kind of sound (continuous, fluctuating, intermittent, impulsive) [14,15]. Noise-induced hearing loss is very costly and huge amounts are paid for workers compensation annually [16].

The mechanisms of noise-induced hearing loss include damage to the inner ear and cochlear hair cells and are irreversible [17]. One of the jobs that the employees are exposed to noise is welding. Welding is one of the most common industries and it is estimated that welders are more than one percent of the workforce in each country [18]. There are approximately 800,000 welders in the world working full time, and many more working part-time [19]. Thus, it is worth to study the occupational risks associated with this industry.

The greatest hearing loss was in billet workers and welders [20]. Hearing loss was more prevalent in the welders and assemblers than in the engineers and administration employees of ship building industry [21]. Welders working in the ship building industry had acquired significant hearing loss [22], also Nilsson et al. showed hearing loss at 4000 Hz in workers working in the same industry [23].

The purpose of this study was to assess the effects of noise exposure on workers' hearing loss and blood pressure changes in a 4 year period in one of the welding saloons of Neyshabur water heater producing factory.

MATERIALS AND METHODS

This study was done in one of the water heater producing factories of Neyshabur in 2010. Due to ethical constraints we were not allowed to mention the name of the factory in this paper but the exact name is present in the Journal office. Among all of the welders in the factory's welding saloon (63 People), those who consented to participate were enrolled in the study.

The inclusion criteria for this study was to be listed as a welder in the organization chart and personnel records, having worked in a welding section for at least 4 years and the existence of audiometries in their medical records file done in 2005 and 2009. Welders who had a history of hearing loss (from before employment), ear trauma, congenital deafness or had

used drugs such as streptomycin or gentamicin were excluded. Workers who had worked in other hazardous jobs before welding or had a second job which could cause hearing loss were also excluded. By considering these factors, the number of participants was reduced to 48. Other information such as the time pattern of exposure and use of personal protective equipment was gathered in a questionnaire or extracted from the workers medical records.

Equivalent sound levels (Leq) of workers noise exposure was measured using the CEL-280 dosimeter model in network A and SLOW mode in 2 hours during working time. Then, using the exposure time of workers and also the background noise level, a level equivalent to daily 8-hour exposure of workers was calculated.

Audiometries were done by a Belton 110-US audiometer and in one of Neyshabur's Occupational Health Screening Centers. Measurements were done in frequencies between 0.5 to 8 kHz and both conductive and sensory neural auditory loss was evaluated. These measurements were performed on both ears, in similar conditions and according to the World Health Organization's standard method [24].

The workers blood pressures were measured in standard conditions and in the Occupational Health Screening Center by the ALK2 sphygmomanometer and in similar conditions on all times.

After data collection and coding, data analysis was performed using SPSS software. The paired *t*-test was used in order to study the difference between hearing thresholds and blood pressures after 4 years. In order to determine the effect of age, work history, smoking and education regression was performed. All data was de-identified before statistical analysis.

RESULTS

The study population was 48 male welders aged from 25 to 50 years, with the average age of 35.6 ± 6.2 years. Their working history varied from 4 to 20 years, with a mean of 7.6 ± 2.1 years. According to self-report, ten cases (20.8%) were smokers and 79.2% (38 cases) were non-smokers. Only 26.9 % (17 cases) of the workers used ear protective devices during their working hours.

The Equivalent Sound Level for 8 hours working on one working day was 97.8 dB in network A and varied from 90 to 110 dB and in all circumstances was higher than the limit determined by the Iranian Technical Committee of Occupational Health (85 dB).

The maximum hearing loss in 2005 was at 4000 Hz and was respectively 19.68 and 23.75 in the left and right ears. In 2009 the maximum amount of hearing loss for both left and right ears was against 4000 Hz, and was respectively, 21.97 and 24.79 dBs. Hearing loss in the right ear was significant at 8000 Hz and in the left ear at 1000, 4000 and 8000 Hz (Table 1).

The results showed that the right ear had a greater hearing loss than the left ear in both years. However

Table 1. Average hearing loss at different frequencies for the right and left ear in 2005 and 2009

| | Frequency (Hz) | Mean hearing loss (dB) in 2005, (SD) | Mean hearing loss (dB) in 2009, (SD) | Max and Min, hearing loss in 2005 (dB) | Max and Min, hearing loss in 2009 (dB) | Difference of means(dB) | <i>p</i> -value |
|-----------|-------------------|--|--|--|--|----------------------------|-----------------|
| Right ear | 500 | 12.91 (6.67) | 13.22 (6.72) | 5-40 | 10-35 | 0.31 | 0.68 |
| | 1000 | 10.79 (7.29) | 12.08 (8.49) | 5-30 | 5-50 | 1.35 | 0.12 |
| | 2000 | 11.04 (7.43) | 11.97 (7.90) | 5-35 | 5-35 | 0.93 | 0.16 |
| | 4000 | 23.75 (14.78) | 24.79 (16.10) | 5-65 | 5-65 | 1.04 | 0.25 |
| | 8000 | 15.93 (13.19) | 21.97 (17.40) | 5-55 | 5-80 | 6.04 | * 0.0001 |
| Left ear | 500 | 11.66 (5.19) | 13.12 (7.62) | 5-35 | 10-45 | 1.45 | 0.10 |
| | 1000 | 9.89 (5.96) | 11.66 (8.33) | 5-35 | 5-55 | 1.77 | * 0.04 |
| | 2000 | 9.89 (5.30) | 11.35 (8.73) | 5-25 | 5-55 | 1.45 | 0.13 |
| | 4000 | 19.68 (13.06) | 21.97 (13.86) | 5-60 | 5-60 | 2.29 | * 0.02 |
| | 8000 | 12.50 (11.01) | 17.39 (17.39) | 5-55 | 5-70 | 4.89 | *0.0001 |

*Statistically significant

there was a significant correlation between hearing loss in the left and right ear in both years. In 2005, the correlation was 0.84 (p value=0.0001) and in 2009 was 0.67 (p value=0.0001).

In 2005, 95.8 percent (46 cases) had normal hearing (NIHL < 25 dB) and only 4.2% (2 patients) had minor damage (26 < NIHL < 40 dB). In 2009 the number of people without hearing impairment had dropped to 91.70 percent (44 cases), 3 cases (6.3%) had minor damage and 1 worker (2.1 percent) had been affected by moderate (41 < NIHL < 60 dB) hearing loss.

Regression analysis was performed to clarify the relationship between age, work history, smoking and education with the difference in hearing loss in both ears. No significant relation was seen between these variables and hearing loss. The p -value for age, work experience, education and smoking was respectively 0.15, 0.73, 0.83 and 0.21. Besides after removing the data for workers aged above 40 years and performing regression there was again no significant relationship between age and hearing loss ($p = 0.92$).

The mean systolic blood pressure during the years 2005, 2007 and 2009, was respectively 11.27 ± 0.91 , 11.42 ± 0.57 and 11.45 ± 0.67 cmHg and showed a non-significant ($p = 0.25$) increase. The mean diastolic blood pressure was respectively 7.33 ± 0.6 , 7.44 ± 0.5 and 7.61 ± 0.7 and also showed a non-significant ($p = 0.08$) increase.

Linear regression was performed to adjust for the effects of age and smoking on increase of blood pressure during 4 years. There was no significant relationship between the increase in blood pressure and these variables ($p > 0.05$).

DISCUSSION

In this study, the noise exposure level equivalent measured was 97.2 ± 0.67 dB and was similar to Ahmadi

et al. study done on metal smoothers of Qazvin, in which the exposure level equivalent obtained was 98.2 dB [25]. Moreover in Taheri et al. study done on coppersmiths of Zanjan, the equivalent level of noise exposure was reported to be 92.8 dB [26]. We did not find any study about welders' noise exposure in the literature.

We did not have an appropriate control group for comparison because all welders were exposed to noise. However, the amount of hearing loss due to age increase in normal individuals has been estimated in other studies.

The normal hearing loss (the cross-sectional rate) in a 15 year longitudinal study was 0.59 dB per year [27] and over a 10 year period the rate of hearing loss was 0.5 dB per year in 4 kHz for unexposed to noise, control subjects who held office jobs [28] which means a 2.36 to 2 dB additional hearing loss in 4 years. If we presume the same has happened in our study, the hearing loss in 8000 Hz is still more than expected.

In this study, the mean hearing loss was higher in the right ear and this result is not in line with some studies that have stated the left ear is more sensitive [13, 24, 29, 30].

The reason for more involvement in the right ear in this study may be the fact that workers dominantly work with their right hand and on the right side. Hearing loss in the current study was not symmetrical and this result is consistent with some studies [13, 25, 27] and not consistent with others [31].

The maximum hearing loss in both years and both ears in our study were in 4000 Hz, which is consistent with studies showing that work-related hearing loss initially occurs at 4000 Hz [13, 24]. However, we did not find any study specifically working on welders hearing loss to compare with.

We did not find a significant relationship between work experience and age with hearing loss, which was similar to the result of Pourabdiyan et al. [32] and Bareba et al. study [33]. However, some studies have reported a significant relationship between work experience and age with hearing loss [29], and the reason maybe the higher average age and work experience of the workers in these studies in comparison to our study. In our study only 15 people were over 40 years old and according to references presbycusis begins at age 40 [34].

In this study the relationship between smoking and education on hearing loss was not significant and this is in agreement with the result of Qhotbi et al. [13] and Aqilinezhad et al. [35]. In some studies a positive relationship has been shown between smoking and hearing loss [36]. In this study, the low number of smokers might have prevented us from reaching a significant association.

In the current study a very low percent (26%) of people had used ear protective devices. The reason of not using the ear protective devices was the lack of adequate training and un-comfortableness of these devices. Not using hearing protection devices because of their un-comfortableness has also been brought up in other studies [37].

The findings of this study might suggest that noise exposure can increase blood pressure in workers. Nevertheless this increase can be the effect of increasing age. References have reported that steady increases in systolic and diastolic blood pressure happens with aging until 50 years [38, 39]. Other authors have reported that repeated or prolonged exposure to stressful industrial noise, can be a predisposing factor to increased blood pressure [9, 40, 41].

CONCLUSION

The results of this study confirm that welders' occupational noise exposure level is higher than standard threshold limits and might lead to gradual increases in blood pressure in addition to hearing loss. Moreover a large percentage of these workers do not use hearing protection which makes the situation even worse. These facts highlight the necessity of training welders for properly using hearing protection equipment.

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