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Noise Induced Hearing Loss of Forest Workers in Turkey

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Abstract: In this study, a total number of 114 workers who were in 3 different groups in terms of age and work underwent audiometric analysis. In order to determine whether there was a statistically significant difference between the hearing loss levels of the workers who were included in the study, variance analysis was applied with the help of the data obtained as a result of the evaluation. Correlation and regression analysis were applied in order to determine the relations between hearing loss and their age and their time of work. As a result of the variance analysis, statistically significant differences were found at 500, 2000 and 4000 Hz frequencies. The most specific difference was observed among chainsaw machine operators at 4000 Hz frequency, which was determined by the variance analysis. As a result of the correlation analysis, significant relations were found between time of work and hearing loss in 0.01 confidence level and between age and hearing loss in 0.05 confidence level. Forest workers using chainsaw machines should be informed, they should wear or use protective materials and less noising chainsaw machines should be used if possible and workers should undergo audiometric tests when they start work and once a year.

Key words: Audiometry, chainsaw operator, noise level

INTRODUCTION

Detrimental effect of high noise level on human health is known for centuries. The general effect of noise on the hearing of workers has been a topic of debate among scientists for a number of years (Eleftheriou, 2002). Nowadays high noise level is considered to be the commonest reason of permanent hearing loss in adults (Osguthorpe and Klein, 1991). Although it is very well-known that high noise level gives rise to hearing loss, we find it necessary to call attention to this problem once again. Such works will be useful to keep the problem on the agenda as hearing loss due to high noise level is an ongoing problem worldwide.

Because of the high noise levels found and the widespread use of hearing protection as a control measure, it is essential to detect incipient noise induced hearing loss (NIHL) and audiometric testing should be carried out. The first step in this is to perform careful baseline audiometric testing in suitable environmental conditions (McBride, 2004).

Although not correctable by medical or surgical treatments, NIHL is the major preventable type of hearing impairment (Dobie, 1993). Thus, the primary prevention of this kind of hearing impairment is the only way to avoid hearing handicap due to noise (Celik *et al*., 1998).

With noise induced permanent threshold shift, there is no possibility of recovery. Noise induced permanent threshold shift can manifest suddenly as a result of acoustic trauma; however, noises that cause noise induced permanent threshold shift most typically constitute exposures that are repeated over a long period of time and have a cumulative effect on hearing sensitivity (Casali, 2006).

Factors such as noise level, time of work and age which have an impact on noise-induced hearing loss should be examined (Paperalla, 1991; Alberti, 1996; Katircioglu, 1998). Noise-induced hearing loss proceeds very slowly (Bergstrom and Nytrom, 1986).

Workers are exposed to high levels of noise during forestry activities, which is very high level of noise (90 dB (A) and over) for chainsaw machine operators and critical level of noise (75-90 dB(A)) for tractor operators whereas other workers are not exposed to high levels of noise (<75 dB (A)).

The purpose of this study is to determine the levels of hearing loss of forest workers in general terms, to put forward the difference of hearing loss levels of chainsaw machine operators who are exposed to high levels of noise than other workers and to examine the effect of age and time of work on hearing loss.

MATERIALS AND METHODS

The study aims to find out noise-induced hearing loss cases of forest workers working under the guidance

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of Zonguldak Regional Directorate of Forestry. This study was conducted during harvesting season in 2008. The workers were categorized into three groups in this context:

- Chainsaw machine operators who are exposed to high levels of noise (90-105 dB (A)) for a long period of time
- Tractor operators who are exposed to high levels of noise (75-90 dB (A)) for a long period of time
- Other forest workers who are not exposed to high levels of noise (<75 dB (A))

The loggers chosen regularly used a chainsaw in their normal work task and consequently were continually exposed to noise levels in excess of 90 dB (A) during their normal working day.

Some questionnaires were drawn up accordingly in order to determine the works that the workers carry out, their ages, their time of work, whether they had another job with high levels of noise, whether they had some problems with their hearing or ears, whether they experienced such problems as head trauma or inflammatory diseases and whether they served as artillery in military service etc. The forest workers were observed not to have used protective equipments such as earplug etc. against noise.

A total number of 114 workers who were in 3 different groups in terms of age and work underwent audiometric analysis. However, 41 workers were not included in the evaluation as they showed differences in terms of the analysis with several reasons. Audiometric analysis was made with Danplex AC 60 audiometer. In addition, the workers included in the evaluation were at similar ages. All workers in this study are younger than 55 years old (Table 1). Consequently, old workers were not included in the evaluation as hearing loss increased its effects at late ages and the young workers were excluded as hearing loss occurred 10 or 15 years later. The study evaluated the total hearing loss which was formed by the data of both age-induced and noise-induced hearing loss.

The analysis of workers who had no problems with their right or left ears and with similar levels of hearing loss in their both ears was accepted for evaluation. The thresholds for left and right ears were compared at each test frequency using Student's t-test for study groups.

Table 1: Numerical data about forest workers in the study

		Age of workers		
Worker groups	N	Mean	Min.	Max.
90-105 dB (A)	39	47.3	42	53
75-90 dB (A)	21	45.6	42	52
<75 dB (A)	23	47.9	44	53

No significant difference was determined ($p<0.05$), thus, based on the results of these tests, only the data obtained from the right ears were used for further analysis.

In order to determine whether there was a statistically significant difference between the hearing loss levels of the workers who were included in the study, variance analysis was applied with the help of the data obtained as a result of the evaluation. As especially chainsaw machine operators who were exposed to high levels of noise were separated approximately at 4000 Hz from other workers, correlation and regression analysis were applied in order to determine the relations between hearing loss and their age and their time of work.

RESULTS AND DISCUSSION

The average level of noise which especially chainsaw machine workers are exposed during the work varies between 90-105 dB (A). However, forest workers continued working without using any kind of protective equipment. Indeed, almost all of the chainsaw operators felt that the noise level at the unit was an unpleasant one.

Only the data about the right ear were used since the t-test analysis suggested that there was no statistically significant difference between two ears in terms of hearing losses. Here, the general distribution of hearing loss values in 6 frequencies belonging to the three worker groups formed as a result of the audiometric analysis were shown in Fig. 1.

When the average levels of hearing loss are examined in Fig. 1, hearing losses in 4000 Hz belonging to the first group are observed to be considerably high. However, variance analysis was carried out in order to determine whether there was a statistically significant difference between the data obtained about hearing losses and the three groups and the results were shown in Table 2. As a

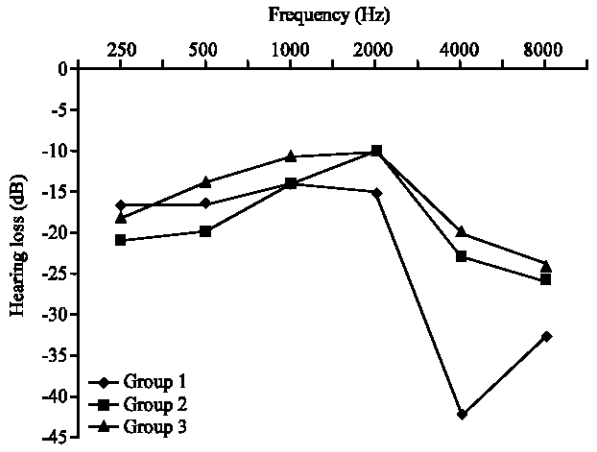

Fig. 1: Hearing loss values in 6 frequencies

Table 2: Hearing thresholds in 6 frequencies of forest workers

Frequencies (Hz)	Worker group	Mean±SD	p-value
250	1	18.21±4.27	0.200
	2	20.71±4.73	
	3	16.09±3.48	
500	1	16.28±3.61AB	0.013*
	2	20.00±3.42A	
	3	13.69±3.24B	
1000	1	13.72±3.67	0.137
	2	14.28±2.99	
	3	10.65±2.82	
2000	1	14.87±4.13A	0.005*
	2	9.52±2.51B	
	3	10.21±2.81B	
4000	1	42.05±9.22A	0.000*
	2	23.09±8.47B	
	3	19.56±7.88B	
8000	1	33.21±9.25	0.084*
	2	25.71±7.75	
	3	24.56±5.34	

*Significant at $p<0.05$, A,B separated groups according to Duncan test

Table 3: Relations among age, time of work and hearing loss

	Age	Time of work
Hearing loss	0.388*	0.789**

*, **Significant at $p<0.05$, <0.01, respectively

result of the variance analysis, statistically significant differences were found at 500, 2000 and 4000 Hz frequencies. The classification made with Duncan test depending on the results of the variance analysis was shown in Table 2.

The most specific difference was observed among chainsaw machine operators at 4000 Hz frequency, which was determined by the variance analysis. Hence, high level of noise occurs to us as important factor which affect hearing loss considerably.

The correlations between the hearing losses at 4000 Hz frequency of chainsaw machine operators who are exposed to high levels of noise and their time of work and age were shown in Table 3.

As a result of the correlation analysis, significant relations were found between time of work and hearing loss in 0.01 confidence level and between age and hearing loss in 0.05 confidence level.

In order to determine the relation between the hearing losses of chainsaw machine operators with their age and time of work, simple linear regression analysis was made by taking hearing losses at 4000 Hz (Y) as dependent variable and age (X_1) and time of work (X_2) as independent variables. The following model was obtained as a result of the regression analysis;

$$Y = -24.822+0.600\ X_1+1.822\ X_2$$

The determination coefficient of the model was calculated as $r^2 = 0.635$. It explains the level of hearing loss, age and time of work in the rate of 63%. In conclusion, it was found out that time of work and then age were effective on the level of hearing loss as well as the level of noise.

The noise between 72-85 dB (A) has negative effects on hearing loss, but this effect is not too considerable. Grave destruction risk occurs after 90 dB (A) (Alberti, 1996; Katircioglu, 1998). A study which investigated noise-induced hearing loss determined that more severe hearing loss occurred among people over the age of 40 and the reason of this might be both long-term noise exposure and presbyacusis (Bayer *et al*., 1985; Simsekli, 1990).

NIHL is usually bilateral and shows a similar pattern in both ears (Ingle *et al*., 2005). As a result of the t-test made in this study, it was found out that hearing loss levels in two ears were similar to each other.

There are many studies which suggest that the more the time of work is the more the hearing loss occurs (Hosal *et al*., 1982; Tonndorf and Kurman, 1984; Gedikli, 1996). The effect of aging on hearing thresholds has been reported long ago. Since this effect is a gradual one, there is no precisely defined onset of this process. Nevertheless, there are some reports which use a limit of 55 years of age for an onset of a detectable age-induced hearing loss (Chen *et al*., 1992; Hasan and Beg, 1994). All subjects participated in the present study were younger than 55 years old. Therefore, it would be reasonable to state that in the present study, age effect did not substantially alter the results. The occurrence of auditory damage could be considered to be due to mainly to the occupational noise. The amount of NIHL and the frequencies involved depend primarily on the acoustic parameters of the noise and the length of exposure (Osguthorpe and Klein, 1991).

Taylor *et al*. (1965) reported the results of a survey of noise and hearing study among Indian hemp workers. Majority of their hearing losses was associated with 4 kHz dip (Celik *et al*., 1998). Hearing loss is encountered at 4000 Hz at most and this frequency may sometimes be 6000 Hz. According to the clinical studies, it is natural to observe that noise-induced hearing loss pattern is in the zone between 3000 and 6000 Hz frequency. 4000 Hz hearing loss which is named as 4000 Hz dip is the primary indicator of sensorineural hearing loss which develops as a result of noise exposure (Merluzzi, 1983; Phaneuf and Hetv, 1990; Dobie, 1993; McBride and Williams, 2001; Casali, 2006). The most resistant frequencies to noise are 250, 500, 1000 Hz and the most resistant among them is determined to be 1000 Hz frequency (Dobie, 1993; Gedikli, 1996; Katircioglu, 1998). The most loss in this study was observed at 4000 Hz and the least loss was observed at 1000 Hz.

The degree of hearing loss is 40-50 dB average. This study found the hearing loss at 4000 Hz as 42 dB, too. The characteristic 4 kHz notch may have several explanations. Of these explanations, three of them have already been generally accepted:

- The greater sensitivity of the human ear to frequencies between 1 and 5 kHz (probably related to outer and middle ear transmission characteristics, mid-range frequencies are emphasized) (Pierson *et al*., 1994)
- After an exposure to intense sound (i.e., in the presence of PTS, or TTS), there is a shift in the maximum basilar membrane vibration towards the basal cochlea by about half an octave upon loss of active cochlear mechanism (Cody and Johnstone, 1981). This means that 1 kHz pure tone will be perceived as 1.5 kHz by the pathologic cochlea
- The effect of the acoustic reflex in attenuating intense sound transmission below about 2 kHz (Dobie, 1985; Katircioglu, 1998)

CONCLUSION

This study determined that the most important factors which affected hearing loss was exposure to high levels of noise first and the time of work second and the age of the workers third. The detected hearing losses were bilateral, symmetrical and affected mainly 4 kHz.

It was also found out that no high level of hearing loss occurred among other forest workers who were exposed to levels of noise under 90 dB (A) and so there was no need for a special precaution. However, it was determined that the chainsaw machine operators who were exposed to high levels of noise over 90 dB (A) experienced high levels of hearing loss at 4000 Hz frequency. Besides, there was a high correlation between the time of work and the hearing loss. In this context, the simple engineering measures taken by forest workers working with chainsaw machines may protect themselves from hearing losses.

Acute or chronic form of industrial noise-induced hearing loss cannot be treated. It is first necessary to protect hearing. Forest workers using chainsaw machines should be informed, they should wear or use protective materials and less noising chainsaw machines should be used if possible and workers should undergo audiometric tests when they start work and once a year.

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