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Effects of Smoking and Body Mass Index on Hearing Thresholds in Workers Exposed to Occupational Noise and Self-Rating Depression Scales

Mesleki Gürültüye Maruz Kalan İşçilerde Sigara İçme ve Vücut Kitle İndeksinin İşitme Seviyesine Etkisi ve Bireysel Olarak Değerlendirilen Depresyon Skalası

Ömer OĞUZTÜRK, Ph.D.*, Nuray BAYAR MULUK, M.D.**
* Kırıkkale University, Faculty of Medicine, Psychiatry Department
** Kırıkkale University, Faculty of Medicine, ENT Department, Kırıkkale

ABSTRACT

Objectives: This prospective study aimed to investigate effects of body mass index (BMI) and Brinkman index on occupational noise induced hearing loss levels; and emotional status of the workers by Zung Anxiety and Depression Scale.
Material and Methods: 72 male workers and 144 ears of them included into the study. Workers were evaluated by a questionnaire form, pure tone audiometry and Zung Anxiety and Depression Scale. Smoking status of them were evaluated; body mass index (BMI), Brinkman index and Self-rating depression scale (SDS) were found.
Results: Thresholds are increased especially at 0.25 and 0.5 kHz; and 4.0 and 6.0 kHz. Mean threshold values seem as "bell type curve". Older age; higher BMI values, higher daily smoked cigarette number caused increase of the hearing thresholds. Higher noise levels (mean or maximum exposed noise) and longer total noise exposure time also caused occupational noise induced hearing loss. Usage of the earheadings prevent the workers from noise induced damage. Mean SDS scores were in normal limits. Higher noise levels and occupational noise induced hearing loss cause increase of the SDS values.
Conclusion: The workers should be educated for the hazardous effects of smoking and being overweight. Sportive actions and life with no smoking may cause positive changes on psychological status of the workers and cardiovascular health-hearing synergism of them.

Keywords
Hearing loss, noise-induced, anxiety, depression, smoking, overweight

ÖZET

Amaç: Bu prospektif çalışmanın amacı, vücut-kitle indeksi ve Brinkman indeksin mesleki gürültüye bağlı işitme kaybı seviyeleri üzerine etkisi; ve Zung Anksiyete ve Depresyon Skalası ile işçilerin emosyonel durumlarını araştırmaktır.
Yöntem ve Gereçler: 72 erkek işçi ve onların 144 kulağı çalışmaya alınmıştır. İşçiler, anket formu, saf ses odyometrisi ve Zung Anksiyete ve Depresyon Skalası ile değerlendirilmiştir. Sigara içme durumu değerlendirilmiş; vücut-kitle indeksi (BMI), Brinkman indeks ve bireysel olarak değerlendirilen depresyon skalası (SDS) bulunmuştur.
Bulgular: Eşikler özellikle 0.25 ve 0.5 kHz; ve 4.0 ve 6.0 kHz'de yükselmiştir. Ortalama eşik değerleri, "çan eğrisi" gibi görülmektedir. İleri yaş, daha yüksek BMI değerleri, daha fazla günlük içilen sigara sayısı, işitme eşiklerinde yükselmeye sebep olmaktadır. Daha yüksek gürültü seviyeleri (ortalama veya maksimum maruz kalınan gürültü) ve daha uzun total gürültü maruziyet süresi de mesleki gürültüye bağlı işitme kaybına sebep olmaktadır. Kulaklık kullanımı, işçileri gürültüye bağlı hasardan korumaktadır. Ortalama SDS skorları normal sınırlar içindedir. Daha yüksek gürültü seviyeleri ve mesleki gürültüye bağlı işitme kaybı, SDS değerlerinde artışa sebep olmaktadır.
Sonuç: İşçilerin, sigara içmek ve kilolu olmanın yol açtığı zararlı etkiler konusunda eğitilmeleri gerekir. Sportif faaliyetler ve sigarasız hayat, işçilerin psikolojik durumları ve kardiyovasküler sağlık-işitme uyumları üzerinde olumlu etkiler yapabilir.

Anahtar Sözcükler
Gürültüye bağlı işitme kaybı, anksiyete, depresyon, sigara içme, şişmanlık

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Correspondence
Nuray BAYAR MULUK, MD
Birlik Mahallesi, Zirvekent 2. Etap Sitesi, C-3 blok, No: 62/43
06610, Çankaya / Ankara
Tel: +90 312 4964073, +90 532 7182441,
Fax: +90 318 2252819
E-posta: nbayarmuluk@yahoo.com, nurayb@hotmail.com

INTRODUCTION

Assessing the degree of noise exposure on individual experiences can be extremely difficult. In most working environments, noise is not continuously sustained and is therefore intermittent. Moreover, many individuals are mobile and move through noisy environments of different intensities for various periods during the workday.[1]

The degree of noise induced hearing loss (NIHL) is influenced by the following: Intensity of the noise, the temporal pattern of the noise (continuous, intermittent, transient), the spectral pattern of the noise (frequency content), the duration of exposure to the noise (time weighted average [TWA]) and individual susceptibility to the noise.[1]

Impulse noise caused increased risk of hearing loss in comparison to continuous noise with the same acoustical energy. The increase of the blood temperature also has been suggested to increase noise-induced temporary threshold shift (TTS) during exercise.[2]

No well-recognized and scientifically validated treatments are specifically directed to NIHL. The following conditions have been alleged to exacerbate NIHL, and appropriate management of these considerations might influence the development or progression of NIHL. These are smoking, cardiovascular disease, diabetes mellitus, hyperlipidemia and exposure to ototoxic drugs.[1]

Hearing impairment (HI) has been shown to cause a number of direct psychological consequences on individuals. Studies have shown on a variety of mental health scales that HI affects psychological well-being.[3-5] Significant correlation is shown between the presence of HI and depression. Individuals suffering from HI are only accurate about 60% of the time in identifying their own hearing deficits. This emphasizes the importance of good screening for depression in patients with known HI.[6]

Noise exposure has been associated with increased catecholamine production and blood pressure elevation in laboratory studies and in human volunteers. Epidemiologic studies have given conflicting results. Stratification by age and BMI revealed increased diastolic pressure in the group with hearing loss under age of 45.[7] Therefore we decided to investigate the relationship between BMI and hearing loss.

In the present study, we investigated some of the factors which affect noise induced hearing loss. The study was planned and continued in Steel Working Factory. Occupational noise induced hearing loss (ONIHL) levels; and effects of smoking and body mass index (BMI) on hearing thresholds were evaluated. Emotional status of the workers was evaluated by Zung Anxiety and Depression Scale; and effects of noise and hearing thresholds on SDS values of the workers were also investigated.

MATERIALS AND METHOD

This prospective study was carried out in the Ear Nose Throat (ENT) and Psychiatry Departments of Kırıkkale University Faculty of Medicine between March and May 2006.

Subjects

The study was carried out in patients exposed to noise during their works in Steel Working Factory in Turkey. 72 male workers and 144 ears of them included into the study with their agreement by written informed consent to participate the study, and to give permission for the use of their all of the laboratory data. Their mean age was 42.1±7.0 (Ranged from 29 to 53).

The workers were evaluated by periodic health check-up in the factory. Under the Industrial Safety and Health Law, auditory examination was performed as a screening program included in periodic health checkups by pure tone audiometry at 0.25 to 6.0 kHz. In the factory, the noise level in the factory was measured and the noise level map of the all departments in the factory was made. Noise levels was measured by Sound Level Meter (Bruel Kjaer Type 2238, Nærum-Denmark) and varied between 73 dB and 110 dB. Noise levels changed at different departments. There were no ototoxic chemical exposures in the factory. The workers were instructed to wear hearing protection devices (protective earheadings or earplugs).

The subjects were asked to complete a self-administered questionnaire; and body mass index (BMI) and smoking status of them were evaluated. Any of the patients in the study group had head trauma; and in the

present time, any symptoms and findings of the infectious ear diseases.

Instrumentation

1. Questionnaire: A history of occupational noise exposure: mean noise for per hour (MN), maximum exposed noise (MEN), daily noise exposure time (DNET) and total noise exposure time (years) (TNET); the type of the noise (temporary, continuous; and continuous with temporary increase); the complaints of the subjects (hearing loss, tinnitus, vertigo, ear ache, fullness of the ear, etc.); the usage of the hearing protection devices [(protective earheadings or earplugs) (never, rare, often, always) (The attenuation provided by the conventional devices alone was 30-37 dB for earmuffs, and 25-28 dB for earplugs[8])]; smoking status (current, past or never smokers) were asked; and Brinkman index (the number of cigarettes smoked per day multiplied by the number of years of smoking) was calculated. The definition of never-smokers was those who smoked fewer than 100 cigarettes during their lifetime.[9]

2. Audiologic examination: All patients were evaluated with 0.25 to 6.0 kHz pure tone audiologic examination. Results were evaluated according to American National Standards Institute (ANSI-1969) standards.[10]

3. Zung Anxiety and Depression Scale: In this scale, there were 20 questions. The subjects' answers were evaluated and Self-rating depression scale (SDS) was found for each of the patients. SDS values were: 1. <50 (Normal), 2. 50-59 (Very-mild depression), 3. 60-69 (Moderate-prominent depression), 4. ≥70 (Severe depression).[11]

Method

In all workers included in the study were evaluated by questionnaire form and Zung Anxiety and Depression Scale. SDS values were found for each of the workers. Relationship between hearing thresholds and exposed noise; and SDS's; and BMI and smoking status of the workers were investigated.

All steps of the study were planned and continued according to the principles outlined in the Declaration of Helsinki.[12]

Statistical analysis

Statistical packet for SPSS (Version 8.0) was used for statistical evaluation. Effects of age, MN, MEN, DNET, TNET; and each of the hearing threshold levels at 0.25 to 6.0 kHz on SDS values were analyzed by "Linear Regression Analysis. Effects of of age, BMI, MN, MEN, DNET, TNET; useage of the earheadings or earplugs; daily smoked cigarettes and Brinkman index on pure tone hearing thresholds were evaluated by "Linear Regression Analysis". p value < 0.05 was considered statistically significant.

RESULTS

BMI, smoking status, SDS values; and characteristics of the noise, steel factory workers exposed to; pure tone audiometry results (0.25 to 6.0 kHz) (Figure

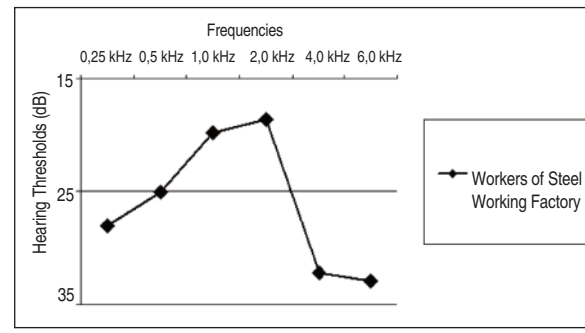

Figure 1. Pure tone audiometry results of the workers

Table 1. BMI, smoking status, SDS values; characteristics of the noise, and pure tone audiometry results (0.25 to 6.0 kHz) are demonstrated

	Mean	St Dev	Minimum	Maximum
Age	42.1	7.0	29.0	53.0
BMI	26.3	3.0	17.7	33.8
Daily smoked cigarettes	7.0	10.4	0.0	50.0
Brinkman Index	132.6	221.0	0.0	1000.0
SDS values	46.4	11.8	25.0	79.0
Characteristics of the noise				
MN	87.6	6.7	70.0	94.2
MEN	99.3	10.2	70.0	110.0
DNET	7.0	0.4	6.0	7.5
TNET	19.0	7.5	2.0	35.0
Hearing Thresholds				
0.25 kHz	28.1	12.9	0.0	90.0
0.5 kHz	25.1	10.5	5.0	90.0
1.0kHz	19.8	10.5	5.0	85.0
2.0kHz	18.6	12.9	5.0	100.0
4.0kHz	32.2	16.9	10.0	95.0
6.0 kHz	32.9	18.4	15.0	110.0

Table 2. Linear Regression Analysis results about effects of MN, MEN, DNET, TNET; and each of the hearing threshold levels at 0.25 to 6.0 kHz on SDS values

	SDS Values	
	Beta	p
MN	-0.131	0.207
MEN	0.252	0.114
DNET	0.309	0.004
TNET	0.114	0.175
Hearing Thresholds		
0.25 kHz	0.172	0.174
0.5 kHz	-0.564	0.073
4.0	kHz	0.450 0.155
5.0	kHz	0.076 0.473
6.0	kHz	0.142 0.335
6.0 kHz	-0.073	0.590

1) are given on Table 1. Total noise exposure time was 19.0±7.5 years (ranged from 2.0 to 35).

Effects of age, MN, MEN, DNET, TNET; and each of the hearing threshold levels at 0.25 to 6.0 kHz on Zung Scores were analyzed by "Linear Regression Analysis. As the MEN; DNET; and TNET increased; and as there was hearing loss at 1-4 kHz; SDS values increased (See on Table 2).

Effects of of age, BMI, MN, MEN, DNET, TNET; useage of the earheadings or earplugs; daily smoked cigarettes and Brinkman index on pure tone hearing thresholds were evaluated by "Linear Regression Analysis". (See on Table 3):

-Older age; and higher BMI values caused increase of the hearing thresholds at 0.25-6.0 kHz.

-When daily smoked cigarette number increased,0.25-4.0 kHz hearing thresholds increased.

-When MN, MEN and TNET increased; pure tone hearing thresholds increased.

-If workers used earheadings, pure tone hearing thresholds decreased, but ear plugs can not be as preventive as earheadings.

DISCUSSION

Experimental animal studies have shown decreased endolymphatic oxygen tension directly related to intensity of noise exposure. Decreases in succinic dehydrogenase and glycogen content have been observed. However, mechanical models are more compatible with the observation that the greatest area of injury in occupational NIHL appears to be to that portion of a cochlea sensitive to frequencies of about 4000 cycles per second (Hz).[1]

Continuous stimuli are more damaging than interrupted stimuli. Intermittent noise is more protective for apical lesions induced by low frequencies than for basal lesions induced by high frequencies. The 4-kHz notch appears to be a consequence of several factors: (1) the fact that human hearing is more sensitive at 1-5 kHz, (2) the fact that the acoustic reflex attenuates loud noises below 2 kHz and (3) nonli-

Table 3. Linear Regression Analysis results about effects of age, BMI, MN, MEN, DNET, TNET, usage of the earheadings and earplugs; daily smoked cigarettes and Brinkman index on hearing thresholds

	Hearing thresholds											
	0.25 kHz		0.5 kHz		1.0 kHz		2.0 kHz		4.0 kHz		6.0 kHz	
	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p
Age	0.110	0.375	0.076	0.538	0.129	0.293	0.194	0.123	0.222	0.057	0.170	0.154
BMI	0.012	0.892	0.028	0.743	0.025	0.766	0.074	0.398	0.168	0.038	0.212	0.012
MN	-0.095	0.393	-0.099	0.375	-0.145	0.190	0.006	0.957	0.019	0.854	-0.174	0.106
MEN	0.006	0.971	0.052	0.768	0.083	0.636	0.071	0.690	0.267	0.107	0.401	0.019
DNET	-0.175	0.145	-0.110	0.361	-0.115	0.336	-0.053	0.663	-0.082	0.466	-0.123	0.287
TNET	-0.063	0.609	0.007	0.958	-0.029	0.814	-0.068	0.584	0.013	0.908	-0.063	0.597
Usage of the earheadings	-0.305	0.064	-0.284	0.085	-0.288	0.077	-0.113	0.495	-0.168	0.275	-0.233	0.141
Usage of earplugs	0.232	0.150	0.175	0.278	0.130	0.417	0.174	0.285	0.300	0.048	0.176	0.256
Daily smoked cigarettes	0.083	0.714	0.109	0.633	0.148	0.513	0.235	0.309	0.082	0.703	-0.172	0.435
Brinkman Index	-0.114	0.618	-0.146	0.523	-0.234	0.304	-0.318	0.171	-0.076	0.722	0.143	0.516

near middle ear function as a result of increased intensities.[1]

The effects of smoking on hearing loss within the context of atherosclerosis was assessed, and the statistical interaction of occupational noise evaluated.[9] In that study, among the total subjects, 13.9% were identified as having hearing loss at 4 kHz, and 38.0% were currently exposed to occupational noise. Smoking was found to be associated with hearing loss beyond occupational noise exposure, and this association seemed to be masked by atherosclerotic factors, suggesting that the direction of the atherosclerotic effect on the relationship might need to be explored between smoking and hearing impairment.[9]

In the present study, we investigated the factors affecting NIHL. In the workers of Steel Working Factory, occupational noise induced hearing loss (ONIHL) levels; and effects of smoking, body mass index (BMI) on hearing thresholds were evaluated. Loud noise exposure related emotional status of the workers was evaluated by Zung Anxiety and Depression Scale; and effects of noise and hearing thresholds on SDS values of the workers were investigated.

Mean values of the hearing thresholds at 0.25-6.0 kHz demonstrated that thresholds are increased over 25 dB normal limits, especially at 0.25 and 0.5 kHz; and 4.0 and 6.0 kHz (Figure 1). Mean threshold values seem as "bell type curve" on Figure 1. The reason for 1.0 and 2.0 kHz thresholds being in normal limits may be related to external auditory canal resonance effect and usage of the earheadings. The resonance effect of the external auditory canal which has maximum in the neighborhood of 2500 Hz may explain this matter. Thus, pure tones (and components of noise) in the frequency region from 2 to 3 kHz reach the inner ear at a higher intensity than do tones at higher or lower frequencies [13,14]. But, as the workers used protective earheadings or earplugs, the resonance effect may be decreased and also inner ear trauma gets lower. As a result, we detected the workers hearing thresholds in normal limits at 1.0 and 2.0 kHz.

In cockpit pilots, it was found that 56% of the 166 pilots suffered from high frequency hearing loss and the percentage increased with flight time. The feature of hearing loss is that it occurs in high frequency at first, then in language frequency, forming a "V" shaped depression at 6 000 Hz. It indicates that cockpit noise may cause permanent threshold shift of hearing.[15]

In the present study, effects of of age, BMI, MN, MEN, DNET, TNET; useage of the earheadings or earplugs; daily smoked cigarettes and Brinkman index on pure tone hearing thresholds were evaluated:

-Older age; and higher BMI values caused increase of the hearing thresholds at 0.25-6.0 kHz.

-When daily smoked cigarette number increased,0.25-4.0 kHz hearing thresholds increased.

-When MN, MEN and TNET increased; pure tone hearing thresholds increased.

-If workers used earheadings, pure tone hearing thresholds decreased, but ear plugs can not be as preventive as earheadings.

In Ferrite S and Santana V's study,[16] age and occupational noise exposures were positively associated with hearing loss. Mizoue T, et al[17] investigated combined effect of smoking and occupational exposure to noise on hearing loss in steel factory workers. Data used were derived from periodic health examinations for steel company workers in Japan and included audiometry testing and information on smoking habits. They founded that smoking was associated with increased odds of having high frequency hearing loss in a dose-response manner. Smoking was not associated with low frequency hearing loss. They concluded that smoking may be a risk factor for high frequency hearing loss, and its combined effect on hearing with exposure to occupational noise is additive.

In the present study, SDS scores were 46.4±11.8. The workers which had SDS values>50[11] were detected and noticed to go to the doctor for psychological evaluation and help.

Effects of age, MN, MEN, DNET, TNET; and each of the hearing threshold levels at 0.25 to 6.0 kHz on SDS scores were analyzed. As the MEN; DNET; and TNET increased; and as there was hearing loss at 1-4 kHz; SDS values increased.

Melamed S, et al[18] investigated the impact of chronic industrial noise exposure on psychological distress symptoms. For males, noise exposure level affected job dissatisfaction and post-work irritability, while for females it also intensified somatic complaints, anxiety and depression. All the distress symptoms were higher for females.

Non-modifiable risk factors related to noise-related hearing loss include increasing age, genetics, male gender, and race. Modifiable risk factors are voluntary exposure to loud noise, nonuse of hearing protection, smoking, lack of exercise, poor diet, tooth loss, and the presence of diabetes and cardiovascular disease.[19]

Cristell M, et al.[20] investigated improvements in both cardiovascular fitness and hearing sensitivity occurred following 2 months of aerobic exercise training. They showed that both pure-tone hearing (2 and 3 kHz) and temporary threshold shifts (TTS) improved following 2 months of exercise training at the evaluated frequencies (2, 3, and 4 kHz) ($p < 0.05$). They concluded that cardiovascular health was associated with hearing sensitivity. Although the mechanisms have not been identified, these results support the existence of a cardiovascular health-hearing synergism.

In the present study, we investigated ONIHL in workers of the Steel Working Company. Mean threshold values seem as "bell type curve". Older age; higher BMI values, higher daily smoked cigarettes caused increase of the hearing thresholds. Higher noise levels (mean or maximum exposed noise) and longer total noise exposure time also caused ONIHL. Usage of the earheadings prevent the workers from noise induced damage. Mean SDS scores were in normal limits. Higher noise levels and ONIHL cause increase of the SDS values.

We recommend workers to use earheadings and not to expose loud noise in their out-work lives. Smoking and being overweight were found to be associated with hearing loss; and the workers should be educated for the hazardous effects of them. Sportive actions and life with no smoking may cause positive changes on psychological status of the workers and cardiovascular health-hearing synergism of them.

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