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Effects of Change of the Thresholds Related to Occupational Noise Exposure on Quality of the Lives of the Workers in Steel Working Factory

Mesleki Gürültü Maruziyetine Bağlı Eşik Değişikliklerinin Çelik İş Fabrikasındaki İşçilerin Hayat Kalitesi Üzerine Etkileri

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ABSTRACT

Objectives: The aim of this study is to investigate the effects of the change of the thresholds (CThs) due to occupational noise on quality of the lives (QOLs) of the workers.

Material and Methods: 29 male workers (58 ears) of Steel Working Factory with two pure tone audiometric evaluation on different times were included. Mean noise for per hour (MN), maximum exposed noise (MEN), daily noise exposure time (DNET) and total noise exposure time (TNET); the type of the noise were evaluated. CThs and the relationship between hearing thresholds and noise exposure; and QOLs of the patients were studied. Using SF-36 Health Survey, eight health concepts were evaluated.

Results: Hearing thresholds were found as increased. Higher MN, MEN, DNET and TNET caused more hearing loss and higher CTh values. And also, continuous noise caused 2.0-6.0 kHz hearing loss; whereas continuous noise with temporary increase caused hearing loss at 0.25-1.0 kHz. With earheadings' protective effect, more effective than earplugs, QOL of the workers is observed as better. With higher age and DNET; and exposing to higher MN and MEN; QOL domains were found as decreased. Increase in the Ch-0.5-2.0 kHz caused decrease of the SF-36 domains.

Conclusion: We concluded that factory workers must be educated for using the protective earheadings; and for hazardous effects of the noise by regular seminar programs.

Keywords

Occupational noise, noise induced hearing loss, health surveys, quality of the life

ÖZET

Amaç: Bu çalışmanın amacı, mesleki olarak maruz kalınan gürültüye bağlı eşik değişikliklerinin (CThs), işçilerin hayat kalitesi (QOLs) üzerine olan etkilerini araştırmaktır.

Yöntem ve Gereçler: Çelik İş Fabrikasındaki 29 erkek işçinin (58 kulak) farklı zamanlarda yapılmış olan saf ses odyometrik değerlendirmeleri alınmıştır. Saatteki ortalama gürültü (MN), maksimum maruz kalınan gürültü (MEN), günlük gürültü maruziyet süresi (DNET), total gürültü maruziyet süresi (TNET) ve maruz kalınan gürültü tipi değerlendirilmiştir. CThs; ve işitme eşikleri ve gürültü maruziyeti; ve işçilerin QOL'leri arasındaki ilişki değerlendirilmiştir. SF-36 Sağlık Taraması kullanılarak, sekiz sağlık konsepti değerlendirilmiştir.

Bulgular: İşitme eşiklerinin yükseldiği bulunmuştur. Daha yüksek MN, MEN, DNET ve TNET, daha fazla işitme kaybı ve daha yüksek CTh değerlerine sebep olmuştur. Ve ayrıca, devamlı gürültü 2.0-6.0 kHz işitme kaybına yol açarken; devamlı gürültü ile birlikte aralıklı olarak yükselen gürültü, 0.25-1.0 kHz işitme kaybına sebep olmuştur. Kulaklıkların koruyucu etkisi kulak tıkaçlarından daha efektif olup işçilerin QOL'leri daha iyi olarak gözlenmiştir. Yüksek yaş ve DNET; ve daha yüksek MN ve MEN'e maruz kalma ile QOL bölümlerinin daha azaldığı bulunmuştur. Ch-0.5-2.0 kHz'da artma, SF-36 bölümlerinde azalmaya sebep olmuştur.

Sonuçlar: Fabrika işçilerinin koruyucu kulaklıkların kullanımı; ve gürültünün zararlı etkileri konusunda, düzenli seminer programları ile mutlaka eğitilmesi gerektiği sonucuna varılmıştır.

Anahtar sözcükler

Mesleki gürültü, mesleki gürültüye bağlı işitme kaybı, sağlık taraması, hayat kalitesi

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INTRODUCTION

Environmental noise is a common cause of hearing loss in industrialized societies. When the injurious noise is present in the workplace, it is referred to as occupational noise-induced hearing loss (ONIHL). In the workplace, high levels of noise may be sustained on a regular basis for many hours each day over many years. Impact noise is more likely to be seen in the context of occupational noise exposure. It is frequency superimposed on a background of more sustained noise. Boettcher[1] has shown that when impact noise is superimposed on continuous noise, the injurious potential is synergistically enhanced.

Zhao YM, et al.[2] studied the dose-response relationship differences between impulse noise exposure workers and continuous noise exposure workers in prevalence of noise inducing hearing loss using dosimeter measurement.The damage of impulse noise on hearing loss was much more than that of continuous noise according to equal energy rule of dosimeter data.

The SF-36 Health Survey [3] is a multi-item global assessment of patient functions. The SF-36 measures eight concepts, called domains. Each domain represented by a series of questions (or items) [4]. It assesses eight health concepts including physical functioning (10 items), role limitations due to physical problems (four items), bodily pain (two items), general mental health (five items), role limitations due to emotional problems (three items), vitality (four items), and general health perceptions (six items). Each scala yields a score of 0-100, with lower scores reflecting greater limitations in function

In the present study, we investigated the effects of the change of the thresholds during the time related to noise exposure on quality of the lives (QOLs) of the workers. The SF-36 Health Survey was performed to evaluate the QOLs of the workers.

MATERIAL AND METHODS

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. 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 1 kHz and 6 kHz. 29 male workers (58 ears), participating in health check-up and having two audiometric tests before, were included into the study as a result of their agreement by written informed consent to participate the study, and by giving permission to use all of their data. Their mean age was 41.4±7.1 (Ranged from 30 to 53). For 6.0 kHz, the initial values were present for 17 workers (34 ears); and the last measurement value were present for 29 workers (58 ears). Therefore, gain of 6.0 kHz value, N value was 34.

All patients were examinated and their medical histories were reviewed. The subjects were asked to complete a self-administered questionnaire. Their two audiometric tests in different times were included into the study. The mean time between two tests was 4.13±2.78 years (Ranged from 1 to 9 years). The workers were instructed to wear hearing protection devices (protective earheadings or earplugs). In the factory, the noise level in the factory was measured by Sound Level Meter (Bruel Kjaer Type 2238, Nærum-Denmark) and the noise level map of the all departments was present. Noise levels varied between 73 dB and 110 dB. There were no ototoxic chemical exposures in the factory. Any of the workers 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).

2. Audiologic examination: All patients were evaluated with 1.0 to 6.0 kHz audiologic examination in a sound-proof booth by calibrated audiometer for two times. Audiological examination results were evaluated according to American National Standards Institute (ANSI-1969) standards.[5]

3. Change of the thresholds (CThs): The difference during the time due to exposed occupational noise was evaluated for each of the frequencies (0.25 to 6.0 kHz). For example, CTh-0.25= Hearing threshold for 0.25 kHz at the last measurement – Hearing threshold for 0.25 kHz at the initial measurement. It means, positive CTh-0.25 kHz values demonstrate that there is hearing loss or increase in the thresholds due to occupational noise exposure during the time. Negative CTh-0.25 kHz values show decrease of the thresholds during the time.

3. The SF-36 Health Survey: The SF-36 Health Survey [3] is a multi-item global assessment of patient function that assesses eight health concepts including:

1. Physical functioning (10 items) (PF),
2. Role limitations due to physical problems (four items) (RP),
3. Social functioning (two items) (SF),
4. Bodily pain (two items) (BP),
5. General mental health (five items) (MH),
6. Role limitations de to emotional problems (three items) (RE),
7. Vitality (four items) (VT)
8. General health perceptions (six items) (GH).

Each scale yields a score of 0-100, with lower scores reflecting greater limitations in function. If the patient indicated to participate the study, questionnaire form given to his/or her and the same doctor gave information for filling the form. Scoring of the questionnaire was completed by hand.

Method

In all patients included in the study were evaluated by questionnaire form; and by SF-36 Health Survey, QOL's of the workers were found. The change of the hearing thresholds and the relationship between hearing thresholds and noise exposure; and QOLs of the patients were studied.

All steps of the study were planned and continued according to the principles outlined in the Declaration of Helsinki.[6]

Statistical analysis: Statistical packet for SPSS (Version 8.0) was used for statistical evaluation. The difference between thr initial and last audiological tests on each of the frequencies was investigated by "Wilcoxon Signed Ranks Test". Effects of age, MN, DNET, TNET, TN; Usage of earheadings (UEh) and earplugs (UEp) on CThs were investigated by Linear Regression Analysis. Correlation between maximum exposed noise and CTh-0.25 to 6.0 was analysed by "Spearman's correlation rho efficient". Effects of age, MN, DNET, TNET, TN; UEh and UEp; and each of the CTh 0.25 to 6.0 on SF-36 health survey domains were investigated by Linear Regression Analysis. Correlation between maximum exposed noise and each of the SF-36 domains was analysed by "Spearman's correlation rho efficient".

p value < 0.05 was considered statistically significant.

RESULTS

Characteristics of the noise, steel factory workers exposed to, are given on Table 1. Pure tone audiometry results (0.25 to 6.0 kHz) on the initial and last measurements and change in the thresholds (CTh) are demonstrated on Table 2. SF-36 health survey results of the workers are given on Table 3.

Table 1. Characteristics of exposed occupational noise.

	Characteristics of the noise			
	Mean	St Dev	Minimum	Maximum
Mean noise for per hour (dB)	90.3	5.3	75.4	94.2
Maximum exposed Noise (dB)	103.8	7.9	83.0	110.0
Daily noise exposure time (hour)	7.3	0.2	7.0	7.5
Total noise exposure time (year)	18.2	7.4	6.0	30.0

Table 2. The results of pure tone audiometry on the initial and last measurements; and change of the thresholds.

Frequencies	Hearing Thresholds						
	Initial Measurement (dB)		The last measurement (dB)		Change of the thresholds (dB)		
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	P*
0.25 kHz	13.8	7.9	29.0	41.2	15.5	9.4	0.000
0.5 kHz	12.0	9.5	24.3	8.0	11.6	9.3	0.000
1.0 kHz	7.2	11.0	18.8	7.1	11.5	11.5	0.000
2.0 kHz	7.3	11.2	20.2	15.5	11.3	10.0	0.000
4.0 kHz	22.2	23.3	33.3	19.1	12.7	14.2	0.000
6.0 kHz	31.0	21.1	33.1	20.1	2.6	14.5	0.345

* Results of the Wilcoxon signed ranks test

The difference between the initial and last audiological tests on each of the frequencies was investigated by “Wilcoxon Signed Ranks Test”. The last measurement values were significantly higher for 0.25-4.0 kHz; and insignificantly higher for 6.0 kHz than the initial values (Table 2).

Effects of age, MN, DNET, TNET, TN; UEh and UEp on CThs were investigated by Linear Regression Analysis. As the MN increased, CTh-0.25 increased. As the DNET increased, CTh-0.25, 4.0 and 6.0 also increased. As the TNET increased, CTh-0.25 and 4.0 increased. As th TN is continuous, CTh-2.0, 4.0 and 6.0 increased. As th TN is continuous with temporary increase, CTh-0.25, 0.5 and 1.0 increased. When the workers used earheadings, CTh 0.25-6.0 decreased. If they used earplugs, onlt CTh-0.25 decreased; but the others, CTh-0.5-6.0, increased (Table 4).

Correlation between maximum exposed noise and CTh-0.25 to 6.0 was analysed by “Spearman’s correlation rho efficient”. As the maximum exposed noise increased, except 2.0 kHz, hearing thresholds were decreased at pure tone levels ($p>0.05$).

Effects of age, MN, DNET, TNET, TN; UEh and UEp; and each of the CTh 0.25 to 6.0 on SF-36 health survey domains were investigated by Linear Regression Analysis. As the workers got older, except BP, all of the SF-36 domains decreased. As the MN increased, PF and MH decreased. As the DNET increased, GH, PF and RE decreased. As the TNET increased, PF and RP decreased; but the other domains are not affected. As the TN is continuous; GH, PF, RE and VT decreased. As the TN is continuous with temporary increase; RP, SF, BP and MH decreased. When workers used earheadings, SF-36 domains increased and QOL of the patients gets better. When they used earplugs, only GH and RE increased.

Table 3. SF-36 Health Survey results of the steel workers.*

Domains	SF-36 Survey Results			
	Mean	St Dev	Minimum	Maximum
PF	86.5	14.5	50.0	100.0
RP	81.0	30.8	0.0	100.0
SF	80.1	20.8	25.0	100.0
BP	74.2	22.5	22.2	100.0
MH	66.6	18.8	28.0	100.0
RE	85.0	32.5	0.0	100.0
VT	59.1	20.1	20.0	100.0
GH	64.0	21.6	20.8	100.0

* St Dev: Standard deviation, PF: Physical functioning, RP: Role limitations due to physical problems (RP), SF: Social functioning, BP: Bodily pain, MH: General mental health, RE: Role limitations due to emotional problems, VT: Vitality, GH: General health perceptions.

Increase in the Ch-0.25 does not affect QOL of the workers. Increase in the Ch-0.5, 1.0 and 2.0 cause decrease GH, PF, RE, BP and VT; RP, SF, BP and MH; and GH, PF, RP and RE, respectively. Increase in the Ch-4.0 and 6.0 cause decrease VT and MH; and GH, PF, RP, SF and BP respectively (Table 5).

Correlation between maximum exposed noise and each of the SF-36 domains was analysed by “Spearman’s

Table 4. Linear Regression Analysis results about effects of age, mean noise, daily noise exposure time, total noise exposure time, type of the noise; usage of the earheadings and earplugs on the change of the thresholds during the time.

	Change of the thresholds during the time (dB)											
	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	−0.153	0.467	−0.144	0.467	−0.101	0.627	0.046	0.837	−0.330	0.142	−0.273	0.472
Mean noise (dB)	0.097	0.505	−0.140	0.305	−0.163	0.257	−0.159	0.307	−0.093	0.546	−0.071	0.773
Daily noise exposure time (hours)	0.022	0.904	−0.070	0.680	−0.098	0.581	−0.024	0.900	0.078	0.684	0.193	0.555
Total noise exposure time (years)	0.182	0.390	−0.053	0.790	−0.190	0.366	−0.261	0.252	0.052	0.815	−0.151	0.652
Type of the noise	0.116	0.481	0.112	0.470	0.148	0.366	−0.101	0.567	−0.122	0.485	−0.315	0.272
Usage of the earheadings	−0.863	0.008	−0.877	0.004	−0.695	0.028	−0.101	0.762	−0.336	0.312	−0.035	0.922
Usage of earplugs	0.471	0.117	0.501	0.077	0.468	0.116	−0.051	0.873	0.302	0.339	0.033	0.921

Table 5. Linear Regression Analysis results about effects of age, mean noise, daily noise exposure time, total noise exposure time, type of the noise; useage of the earheadings and earplugs; change of the thresholds during the time on SF-36 Survey Results*

	SF-36 Survey Results															
	PF		RP		SF		BP		MH		RE		VT		GH	
	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p
Age	−0.084	0.780	0.053	0.781	−0.339	0.236	0.111	0.619	−0.169	0.540	−0.184	0.402	−0.359	0.319	−0.539	0.073
Mean noise	−0.089	0.627	0.433	0.001	0.423	0.021	0.292	0.041	−0.375	0.034	0.617	0.000	0.172	0.428	0.510	0.008
Daily noise exposure time (h)	−1.294	0.000	0.155	0.331	0.490	0.046	0.347	0.071	0.682	0.007	−0.456	0.019	0.442	0.144	−0.584	0.022
Total noise exposure time (yr)	−0.186	0.463	−0.047	0.767	0.874	0.001	0.597	0.004	0.306	0.194	0.744	0.001	0.597	0.056	0.618	0.017
Type of the noise	0.922	0.001	−0.472	0.006	−0.224	0.333	−0.243	0.188	−0.765	0.002	0.687	0.001	0.130	0.654	0.679	0.008
Usage of the earheadings	0.790	0.030	0.530	0.022	0.520	0.115	0.606	0.025	0.979	0.005	−0.084	0.734	0.617	0.137	−0.056	0.863
Usage of earplugs	−0.705	0.015	−0.263	0.132	−0.036	0.884	−0.550	0.011	−0.421	0.098	0.451	0.029	−0.143	0.653	0.052	0.841
Change of the thresholds																
0.25 kHz	0.058	0.839	−0.602	0.003	0.310	0.251	0.318	0.141	0.574	0.037	0.566	0.011	0.942	0.010	0.118	0.666
0.5 kHz	−0.158	0.697	0.195	0.448	0.040	0.916	−0.200	0.505	0.000	1.000	−0.438	0.146	−0.526	0.278	−0.598	0.133
1.0 kHz	0.108	0.750	−0.031	0.881	−0.166	0.603	−0.163	0.517	−0.170	0.587	0.179	0.469	0.369	0.362	0.296	0.367
2.0 kHz	−0.248	0.355	−0.180	0.289	−0.416	0.104	−0.143	0.468	−0.272	0.269	−0.459	0.025	−0.641	0.051	−0.626	0.021
4.0 kHz	0.713	0.023	0.234	0.214	0.157	0.567	0.056	0.795	−0.495	0.076	0.257	0.234	−0.109	0.753	0.590	0.046
6.0 kHz	−0.076	0.734	−0.004	0.976	−0.181	0.392	−0.173	0.303	0.010	0.962	0.074	0.647	0.013	0.961	−0.102	0.634

* PF: Physical functioning, RP: Role limitations due to physical problems (RP), SF: Social functioning, BP: Bodily pain, MH: General mental health, RE: Role limitations due to emotional problems, VT: Vitality, GH: General health perceptions

correlation rho efficient". As the maximum exposed noise increased; GH (p=0.034), PF (p=0.029), RP (p=0.001), RE (p=0.001), and SF (p=0.101) significantly; and VT (p>0.05) and MH (p>0.05) insignificantly decreased.

DISCUSSION

Dobie[7] listed criteria for the diagnosis of ONIHL, as follows: 1-ONIHL is always a neurosensory loss. 2-ONIHL is almost always bilateral. 3- High-frequency losses rarely exceed 75 dB, and low-frequency losses rarely exceed 40 dB. 4- Loss is always greater at the frequencies 3000-6000 Hz than at 500-2000 Hz. Loss is usually greatest at 4000 Hz. The 4000-Hz notch is often preserved even in advanced stages.

In the present study, we found that pure tone hearing thresholds increased significantly at 0.25-4.0 kHz and insignificantly at 6.0 kHz related to noise exposure in their worklives. Higher MN, MEN, DNET and TNET caused more hearing loss and higher CTh values. And also, continuous noise caused 2.0-6.0 kHz hearing loss; whereas continuous noise with temporary increase cause hearing loss at 0.25-1.0 kHz. Usage of earheadings protect workers hearing levels at all of the pure tones. Earheadings' protective effect from the noise induced hearing loss is more effective than earplugs.

We investigated the QOL of the workers due to occupational noise by SF-36 health Survey. Olders workers, exposed to higher MN, MEN and DNET , QOL domains were found as decreased. As the TNET increased, PF and RP decreased; but the other domains are not affected. This may be related that the workers who work noisy environment for long years, used to live with their hearing loss and they may be talk with higher voice tone in their social and work lives. Therefore, they are not disturbed by socially and emotionally. Continuous noise affect physical health of the workers; but continuous noise with temporary increase; affects mainly workers' emotional status.

When workers used earheadings, SF-36 domains increased and QOL of the patients gets better. It may be concluded that, UEhs prevent the workers from the noise induced hearing damage and QOL of the workers is observed as better. UEps affect QOL in a positive way; but it is not as preventive as earheadings.

Increase in the Ch-0.5-2.0 kHz cause decrease of the SF-36 domains. As we know that 0.5-2.0 KHz are speaking thresholds; and hearing thresholds of 500, 1000, 2000, and 3000 Hz are critical for understanding human conversation;[5] any damage or decrease in these thresholds affects QOL of the workers negatively. Hearing loss at higher frequencies also cause worsening in QOLs of the workers.

In Tabuchi, et al.[8] studied on noise and hearing loss was conducted in 36 small-scale factories where press machinery is actively used. Twenty-one (91%) of those workers measured were exposed to 85 dB or higher, (the occupational exposure limit for an 8-hour exposure period). Maximum exposure levels were found to be at 102 dB. It was found that as workers' ages increased, the percentage of workers having some degree of hearing loss increased. Specifically, it was found that there was some level of hearing loss for 93% of those studied aged in their 50's, and up to 100% in those aged in their 60's.

Maisarah and Said [9] investigated the prevalence of sensori-neural hearing loss among the noise exposed and the non-noise exposed workers, to study their knowledge on the hazard of noise to hearing and the workers' attitude towards the hearing protection devices. The prevalence of sensori-neural hearing loss was significantly higher among the noise exposed workers, i.e., 83% versus 31.7%. Although hearing protection devices were provided to 80.5% of the workers, only 5.1% were wearing them regularly. The possibility of developing hearing loss due to exposure to excessive noise was only known by 35.5% of the noise exposed workers. This awareness was found to have a positive correlation with the workers' compliance to the hearing protection devices. Their findings highlight the need for workers to be educated on the hazards of excessive noise exposure to hearing.

Earplugs are effective only when properly inserted. When earplugs are improperly inserted, noise attenuation may be eliminated or greatly reduced. Earplugs are especially useful when noise exposure is continuously sustained. The most effective ear protection is the ear protection the person will wear.

Among possible therapies after acute acoustic trauma, hyperbaric oxygenation (HBO) combined with corticoid was found effective in several animal studies. Such evidence was obtained for moderate 20-25 dB losses. Combined HBO and corticoid therapy provided significant protection from noise-induced loss of auditory thresholds, especially when started one day post-exposure. Hearing loss reduction induced by HBO combined with corticoid was of similar magnitude (about 10-15 dB)[10,11]

In the cochlea, glucocorticoid receptors are associated with stria vascularis, spiral ligament, spiral limbus and spiral ganglion, and to a lesser extent, the organ of Corti.[11-14] Intra-cochlear infusion of dexamethasone, a member of the glucocorticoid family of steroids, protects hair cell survival and auditory function from toxic effects of noise,[11,15,16] noise down-regulates glucocorticoid receptors in the cochlea.[11,17] The protective effects of dexamethasone may be a consequence of blood-flow promoting properties of dexamethasone in the inner ear.[11,18] Alternatively, glucocorticoid-based protection may result from rapid modulation of calcium channels and calcium mobilization as described in other biological systems. For example, corticosteroids may inhibit calcium entry in auditory cells, thus reducing excitotoxic injury, and reducing NIHL.[11,18] Consistent with this suggestion, Lamm and Arnold[15] speculated that prednisolone may reduce NIHL in part via actions at mineralocorticoid receptors, activation of the enzyme Na,K-ATPase, and restoration of disturbed cellular osmolarity.

It was found that glucocorticoids given during and/or after exposure to the noise have a cytoprotective activity to the hair cells, they limitate the extensiveness and decrease the dynamics of hair cells injury. new "young" hair cells reappeared at the sensory epithelium on the 7th day after the end of exposure. Regenerated hair cells have immature, short and thick cilia and small apical surface area.[19]

In the present study, as the degree of occupational noise induced hearing loss increased by exposure to higher MN and MEN values with longer daily and tottaly noise exposure time; in these factories, the workers must have knowledge about noise induced hearing loss. And, they should use hearing protection devices, such as protective earheadings; and if necessary, the workers must be educated on this matter by regular educational seminar programs. Using earheadings, QOLs of the workers get better and hazardous effects of the noise on workers physical and emotional health may not be observed as too much.

In factory workers, periodic health checkups must be done regularly; and the workers should be informed about the usage of the ear protection devices.

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