Archives of Occupational Health | Volume 2 | Issue 2 | April 2018 | 121-7.

Original

The Relationship between Individual Risk Factors and Hearing Loss in Textile Workers

Amir Hossein Khoshakhlagh[1], Saeid Yazdanirad[2]*, Vali Sarsangi[3]

[1]Department of Occupational Health Engineering, Faculty of public Health, Tehran University of Medical Sciences, Tehran, Iran & Students' Scientific Research Center, Tehran University of Medical Sciences, Tehran, Iran•[2] Department of Occupational Health Engineering, Faculty of public Health, Tehran University of Medical Sciences, Tehran, Iran•[3] Department of Occupational Health Engineering, Faculty of public Health, Tehran University of Medical Sciences, Tehran, Iran•Corresponding author: SaeidYazdanirad, Email:saeedyazdanirad@gmail.com, Tel: +98-913-4084163

Abstract

Background: Noise-induced hearing loss (NIHL) is a debilitating and irreversible disease and one of the ten most important occupational diseases. The purpose of this study was to investigate the relationship between individual risk factors and NIHL in textile workers. **Methods:** This cross-sectional study was carried out on 128 employees of one of the textile factories of Tehran Province in 2017. At first, data were collected using a demographic questionnaire including age, marital status, level of education, and work shift. Then, using an audiometer, the workers' threshold of hearing was measured in both ears for frequencies of 500, 1000, 2000, 4000, and 8000 Hz, and data were analyzed by the SPSS version 18.**Results:**The mean age of the workers was 30.59 (3.5) years, their mean work experience 5.7 (2.76) years, and the mean environmental noise level at work 87.88 (6.13) dB. The findings showed that there was a significant relationship between the level of exposed noise and age, education level, work shift, and marital status. **Conclusion:** Increased age of population and level of environmental noise are two factors for increased hearing loss, which can be partly prevented by using engineering approaches such as using mufflers and silent rooms.

Keywords: Noise; Hearing loss; Audiometry; Important risk factors for hearing loss

Introduction

The development of modern automatic machines in the industry has significantly reduced the physical load of workers, and, on the other hand, has increased the production and productivity of industrial enterprises. One of the undesirable and unavoidable byproducts of these operations and equipment is noise pollution. In most countries across the globe, the association between noise exposure and hearing loss is known. Following the Industrial Revolution, continuous noise was introduced into work environments and its influence on the workers' hearing system expanded.[1]

Long-term exposure to excessive noise without taking necessary precautions can have detrimental effects on the function of various parts of the body. These effects include hearing loss, mental disorders, reduced efficiency, and undesirable effects on the circulatory system.[2-4] The biological basis for noise-induced hearing loss (NIHL) is a combination of mechanical and metabolic factors. Chronic exposure of cochlear hair cells to excessive noise and metabolic changes due to hypoxia caused by

Citation: Khoshakhlagh AH, Yazdanirad S, Sarsangi V.**The Relationship between Individual Risk Factors and Hearing Loss in Textile Workers.**Archives of Occupational Health. 2018; 2(2): 121-7.

Article History: Received: 16November 2017; Revised: 20December 2017; Accepted: 21January 2018

contraction of blood capillaries as a result of exposure to noise can lead to hearing loss.[5,6] NIHL is one of the most commonly occurring work-related illnesses in the world, so that it is among the 10 leading occupational diseases in Canada and the United States.[7,8]

Noise-induced damage to the hearing system can occur as three ear diseases, i.e., NIHL, acoustic trauma, and tinnitus. Hearing loss is divided into two types, temporary threshold shift (TTS) and permanent threshold shift (PTS).[9] PTS is caused by the destruction of the hair cells of the Organ of Corti and is often irreversible.[10] To make definite diagnosis of hearing loss, pure-tone audiometry must be used (7, 8). Increased threshold of hearing in audiometry in people exposed to noise can indicate damage to their cochlea.[11] So far, different statistics have been published that reveal that occupational exposure to this detrimental factor is widespread in the employees of different occupations. Occupational Safety and Health Administration (OSHA) has estimated that over 7.9 million industrial workers in the United States are exposed to over 80 dB noise due to their work.12 On the other hand, according to estimates by the Environmental Protection Agency (EPA), more than 9 million US workers in industry sectors are exposed to noise levels of, or exceeding, 80 dB.[12]

According to the OSHA, the National Institute on Deafness and Other Communication Disorders (NIDCD), and the American Speech-Language-Hearing Association (ASHA), more than 30-40 million Americans are regularly exposed to hazardous levels of noise. Occupational NIHL is estimated to have affected 10-15 million people in all age groups in the United States.[13,14] One fourth of workers who have the history of exposure to sound levels exceeding 90 dB during their working lives will develop hearing loss due to occupational noise exposure.[12] In Sweden, about 9% of all workforces are continuously introducing into exposure to a hazardous noise level, and NIHL is very costly so that roughly 100 million dollars is paid annually to compensate for the disease in the country; the Canadian compensation board has estimated the mean cost paid for hearing loss claim 14000 Canadian dollars.[15]

In the United States, compensation for hearing loss claim in 1990 was estimated to be roughly 200 million dollars.[16] In Greece, in 2001, 10% of the burden of occupational disease was due to noise exposure.[17] A number of studies in recent decades have been conducted to evaluate the occupational environment in industries. Most of these studies have been carried out in developed countries, while a large part of industries causing high levels of noise, such as the textile industry, across the world have been established in developing countries.[15] Hearing loss caused by exposure to high levels of noise is dependent on various factors such as exposure duration, frequency, and level and type (continuous or percussion) of sound. On the other hand, there are a number of demographic characteristics that may have a direct or indirect effect on NIHL. Considering the importance of this issue and also considering that the textile industry is an important industry in terms of noise exposure, this study was conducted to investigate the relationship between individual risk factors and NIHL in textile workers.

Methods

In this cross-sectional study, the hearing status of 128 workers in a textile factory in Tehran Province in 2017 was investigated. For sampling, all people who had exposure to high levels of noise were included in the study. All workers worked 8 hours a day, 5 days a week. Inclusion criterion was exposure to noise level above 85 dB. To control confounding factors, the people with temporary threshold shift (TTS), job change, exposure to toxins affecting the sensor neural hearing loss such as mercury, lead, cobalt, and urea, and the use of drugs that affect the mechanism of hearing such as desferrioxamine, salicylates, quinines, mandelamine, aminoglycosides, and antibiotics and diuretics affecting the loop of Henle

(Furosemide and Adrien) were excluded from the study as confounders.[7]

Then, people who were eligible to participate in the study were invited to the factory's Occupational Health Care Unit to undergo the audiometry. Before the study, the stages of the study were explained to them and then they signed written consent to participate in the study. Before performing the audiometry, demographic data including age, work experience, job type, work shift, and education level were collected by using a questionnaire. To perform the audiometry, pure-tone audiometry was used. To this end, ear of people with earwax was washed. Audiometry was then performed through air conduction at frequencies from 500-8000 Hz.

Audiometry was performed in a quiet audiometric test room (40 dB) and both ears of the workers were examined for NIHL by an eligible audiologist using an audiometer (Belton 2000 Clinical Audiometer) at frequencies of 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz according to a scientific method.[7] The workers' audiometric baseline information was collected from their medical records. According to the OSHA, if the average difference observed between the last audiogram and baseline audiogram at the frequencies of 2000, 3000, and 4000 Hz is at least 10 dB in either ear, hearing threshold shift has occurred (18). Then, workers were classified based on the type of job and the noise level that each group of workers with the same job had exposure to, was measured by dosimeter and average logarithmic values were calculated to determine their exposure.[1.17] In addition, in the workers using hearing protectors, the effective noise reduction of the phone (50% of the tagged value of the noise reduction ratio (NRR) was deducted from noise exposure measured by the dosimeter. Finally, after data were entered in the SPSS version 18, ANOVA, the LSD, and t-test were used for data analysis. The significance level in the study was considered 0.05.

Results

The measures of central tendency and dispersion of demographic characteristics and NIHL in the participants are shown in Table 1. In the factory, the workers had an average noise exposure of 87.88 (6.13)dB. The mean hearing loss of the left and right ear was 18.22 (11.91) dB and 19.51 (11.18) dB, respectively. The one-way ANOVA results of NIHL in different age groups were significantly different (P = 0.001).

The results on variables such as job type, education level, environmental noise level, work shift, and marital status indicated that there was a significant relationship between each of the variables and occupational NIHL, while the work experience of individuals did not have any significant relationship with NIHL. The significance level between different demographic groups is shown in Table 2. The results of the LSD showed a significant difference in average hearing loss between group 3 and groups 1 and 2. The results also showed that there was a significant difference in NIHL between the ring operator and other operators and workers. The rate of hearing loss was significantly different between people with education levels lower than high school diploma and those with high school diploma and bachelor's degree. The difference in hearing loss between the people working in morning shifts and those in rotating shifts was significant. The rates of hearing loss for the various frequencies in single and married people are shown in Table 3.

Table 1. Measures of central tendency and dispersion of demographic characteristics and noise-induced hearing loss in participants

Variable	Group no.	Group	Frequency	Percentage	Mean noise-induced hearing loss	Standard deviation
Age (yr)	1	22-29	54	42.20	15.84	8.87
	2	30-34	55	42.96	15.56	9.79
	3	Over 35	19	14.84	25.35	11.59
Education level	1	Under high school diploma	56	43.75	19.78	11.12
	2	High school diploma	67	52.34	15.64	9.03
	3	Associate's degree and bachelor's degree	5	3.91	7.58	4.87
Work experience (yr)	1	1-4	41	32.03	16.49	9.73
	2	5-9	65	50.78	16.96	9.77
	3	Over 9	22	17.18	18.87	12.55
Type of job	1	Ring operator	36	28.10	23.48	9.12
	2	Doubling machines Operator, etc.	36	28.10	19.18	10.32
	3	Other jobs	56	43.80	11.74	7.87
Marital status	1	Single	17	13.28	12.00	5.82
	2	Married	111	86.72	17.92	10.54
Work shifts	1	Morning shift	12	9.37	5.92	3.40
	2	Afternoon shift	2	1.50	10.31	3.90
	3	Rotating shift	107	83.60	18.75	10.13
	4	Morning and afternoon shift	7	5.46	13.72	6.98

Table 2. Significance levels of differences among different demographic categories

Parameters	I	J	Mean difference between I and J groups	*P*-Value (significance level)	95% confidence interval Lower limit	Upper limit
Age group	1	2	0.30	0.87	-3.37	3.98
		3	-9.48	0.001	-14.61	-4.36
	2	1	-0.30	0.87	-3.98	3.37
		3	-9.79	0.001	-14.90	-4.67
	3	1	9.48	0.001	4.36	14.61
		2	9.79	0.001	4.67	14.90
Job group	1	2	4.30	0.04	0.12	8.48
		3	11.74	0.001	7.94	15.53
	2	1	-4.30	0.04	-8.48	-0.12
		3	7.43	0.001	3.64	11.22
	3	1	-11.74	0.001	-15.53	-7.94
		2	-7.43	0.001	-11.22	-3.64
Education level	1	2	4.14	0.02	0.59	7.69
		3	12.20	0.009	3.04	21.36
	2	1	-4.14	0.002	-7.69	-0.59
		3	8.06	0.08	-1.03	17.15
	3	1	-12.20	0.009	-21.36	-3.04
		2	-8.06	0.08	-17.10	1.03
Work shift	1	2	-4.39	0.58	-18.83	10.05
		3	-12.83	0.001	-18.58	-7.07
		4	-7.80	0.08	-16.79	1.19
	2		4.39	0.54	-10.05	18.83
		3	-8.43	0.21	-21.93	0.05
		4	-3.40	0.65	-18.57	11.75
	3	1	12.83	0.001	-7.07	18.58
		2	8.43	0.21	-5.58	21.93
		4	5.03	0.18	-2.34	12.41
	4	1	7.80	0.08	-1.19	16.79
		2	3.40	0.65	-11.75	18.57
		3	-5.03	0.18	-12.41	2.34

Table 3. The rates of hearing loss for various frequencies in single and married people

		Frequency	Mean	Standard deviation	95% confidence interval (CI) Lower limit	Upper limit	Minimum	Maximum
Hearing loss in the right ear at 500 Hz	Single	17	18.23	10.14	13.01	23.45	5.00	40.00
	Married	111	26.21	13.57	23.66	28.76	5.00	55.00
	Total	128	25.15	13.41	22.81	27.50	5.00	55.00
Hearing loss in the right ear at 1000 Hz	Single	17	18.23	9.83	23.29	23.29	5.00	35.00
	Married	111	24.68	22.18	27.18	27.18	0.00	65.00
	Total	128	23.82	21.55	26.10	26.10	0.00	65.00
Hearing loss in the right ear at 2000 Hz	Single	17	11.47	7.65	7.53	15.40	0.00	25.00
	Married	111	16.35	11.88	14.11	18.58	0.00	55.00
	Total	128	15.70	11.51	13.68	17.71	0.00	55.00
Hearing loss in the right ear at 4000 Hz	Single	17	8.82	6.00	5.73	11.90	0.00	20.00
	Married	111	14.05	12.44	11.70	16.40	0.00	60.00
	Total	128	13.35	11.93	11.27	15.44	0.00	60.00
Hearing loss in the right ear at 8000 Hz	Single	17	7.94	6.38	4.65	11.22	0.00	25.00
	Married	111	12.34	11.88	10.10	14.57	0.00	75.00
	Total	128	11.75	11.39	9.76	13.75	0.00	75.00
Hearing loss in the left ear at 500 Hz	Single	17	13.52	6.31	10.28	16.77	5.00	25.00
	Married	111	22.65	13.81	20.05	25.25	5.00	65.00
	Total	128	21.44	13.41	19.09	23.79	5.00	65.00
Hearing loss in the left ear at 1000 Hz	Single	17	17.64	11.33546	11.81	23.47	5.00	50.00
	Married	111	23.24	14.43	20.52	25.95	0.00	70.00
	Total	128	22.50	14.15	20.02	24.97	0.00	70.00
Hearing loss in the left ear at 2000 Hz	Single	17	10.88	11.62	4.90	16.85	0.00	50.00
	Married	111	16.17	12.61	13.79	18.54	0.00	60.00
	Total	128	15.46	12.57	13.26	17.66	0.00	60.00
Hearing loss in the left ear at 4000 Hz	Single	17	8.23	7.05	4.60	11.86	0.00	30.00
	Married	111	14.27	13.20	11.79	16.76	0.00	70.00
	Total	128	13.47	12.71	11.25	15.70	0.00	70.00
Hearing loss in the left ear at 8000 Hz	Single	17	7.94	6.62	4.53	11.34	0.00	25.00
	Married	111	13.73	12.23	11.43	16.04	0.00	60.00
	Total	1287	12.96	11.79	10.90	15.03	0.00	60.00

Table 4. The results of regression analysis of the effect of different variables on hearing loss

Model		Unstandardized coefficients B coefficient	Standard error	Standardized coefficients coefficient B	t	Significance level
1	-	-71.21	10.44	-	-6.81	0.001
	Noise level	1.01	0.11	0.60	8.48	0.001
2	-	-78.01	10.11	-	-7.71	0.001
	Noise level	1.01	0.11	0.60	8.95	0.001
	Age group	3.66	0.98	0.25	3.73	0.001
3	-	-48.01	12.99	-	-3.69	0.001
	Noise level	0.74	0.13	0.44	5.56	0.001
	Nominal group	4.30	0.95	0.29	4.49	0.001
	Job group	-3.43	0.99	-0.28	-3.46	0.001
4	-	-33.47	14.01	-	-2.38	0.018
	Noise level	0.65	0.13	0.39	4.84	0.001
	Age group	4.36	0.93	0.30	4.64	0.001
	Job group	-3.69	0.97	-0.30	-3.78	0.001
	Education level	-2.44	0.98	-0.16	-2.48	0.014

The coefficients and factors affecting each variable relative to hearing loss, which were derived from the regression analysis, are shown as equation below.

Noise-induced hearing loss= -33.478 (Noise level) +0.654 (Age group) +4.363 (Job group) -3.695 (Education level) -2.446

The results of the regression analysis of the effect of different variables on hearing loss are shown in Table 4.

The results of the t-test showed that there was no significant difference in hearing loss between the left ear and the right ear. In addition, the regression analysis showed that the effect of noise level on hearing loss was greater than those of other variables, and then age had the greatest impact on hearing loss followed by the type of job and education level.

Discussion

The environment of textile factories is conventionally associated with high noise levels so that noise level is often more than 110 dB in some units. In the present study, a significant relationship was observed between age and hearing loss. Significant relationship between age and hearing loss as well as between occupational environment noise level and NIHL is consistent with the results of a study by Hang et al. in Korea (2001). In this study, the relationship between these variables and NIHL was investigated by using multivariate statistical analysis.19Another study by et al. (2001) to investigate the effect of age variables, exposure to high noise levels, and other risk factors on NIHL, showed direct correlations of NIHL with noise level in work environment and age.[20]

The results of study in 535 metal workers (2005) also showed a direct correlation between age and exposure to high levels of noise in work environment, which are two important factors for occupational NIHL.[21] This is consistent with our results. Meanwhile, the study of indicated that smoking effect was exacerbated by these factors. Age is considered a major risk factor for hearing loss in the elderly.

Age-related changes may have adverse impacts on nerve fibers, blood supply to nerve fibers in the brain, and inner and outer hair cells, and lead to progressive defects.[22] These results are also in agreement with the results of a 4-year study by in the United States.[23] The current study also showed that with increasing the noise level of the work environment, hearing loss increased. The results of et al.'s investigations in different industries showed a significant, direct correlation between work environment noise level and the severity of occupational NIHL.[24] The study of the Barba in Brazil also showed a significant relationship between noise level and standard threshold change.[25]

The results of our study are consistent with the results of these studies. In addition, the results of the present study showed that there was a significant relationship between hearing loss and work shift so that hearing loss in people working in circulating shifts was higher, which may be due to the fact that these people have less time to rest and repair because people working in rotating shifts may have sleep disorders and problems. The rate of hearing loss was higher in married people than in single people.

Married people may be more exposed to noise due to more social and economic activities, even outside their original work shift, than single people. According to the findings, the lowest hearing loss was observed in those with an associate's degree and higher education levels.

This suggests that people with higher education levels use hearing protectors more frequently to protect their hearing system because they have a better understanding of the adverse effects of noise on hearing loss. On the other hand, the people with higher education level often work in higher-level occupations, which causes them to be exposed to noise for comparatively less time. In the present study, although people with higher work experience were found to have higher hearing loss, there was no significant relationship between work experience and the amount of threshold of hearing, which is consistent with the results of Barba.[25] However, the results of Osibogun et al. showed that threshold of hearing in the people exposed to noise increased with increasing their work experience.[26] This observation can be attributed to the fact that, often hearing loss begins in the first decade of employment, and people who have not experienced significant changes in their threshold of hearing during this period are unlikely to develop hearing loss in the long term. Workers may also have used hearing loss protectors to prevent the progression of hearing loss due to observing mild adverse effects of noise during the initial years of their work.

Conclusion

The results of this study showed that there was a significant relationship between hearing loss and demographic factors such as age, noise level, marital status, education level, and work shift. This information can be used to prioritize the control of noise in the work environment of people who are predisposed to hearing loss, or to transfer them from noisy occupational environments to the occupations with comparatively less noise exposure.

Conflict of interest

The authors declare no conflict of interest.

Acknowledgement

The authors appreciate the workers who participated in this study.

References

1. Nezamodini Z S, Hashemi Z, Yazdi M, Saedei R. Evaluation of different hearing loss disorders among cane industry workers. Iran occupational health. 2014; 11(3): 40-47.
2. Berger EH, Franks JR, Behar A, Casali JG, Dixon-Ernst C, Kieper RW, et al. Development of a new standard laboratory protocol for estimating the field attenuation of hearing protection devices. The journal of the acoustical society of america. 1998;103(2):665-72.
3. Ward WD. Endogenous factors related to susceptibility to damage from noise. Occupational medicine. 1995;10:561-75.
4. Hétu R, Getty L, Quoc HT. Impact of occupational hearing loss on the lives of workers. Occupational medicine. 1995;10(3):495-512.
5. Clark WW, Bohne BA.Effects of noise on hearing.JAMA. 1999;281(17):1658-9.
6. Shafey O, Dolwick S, Guindon GE. Tobacco control country profiles. Consume de tabaco en medico's residents de pediatric en la Argentina. Prevalence actual y tendency en los. 2ed ed. USA: who. 2003;356-62.
7. Katz J. Handbook of clinical audiology. 5th ed. Baltimore: Philadelphia: lippincott; 2002.P:125-30.
8. Mc Bride DI. Noise induced hearing conversation in mining. Occupational medicine. 2004;54(5):290-6.
9. Kiakojouri, K, Sheikhzadeh M, ShahaniKalaki M, Monadi M, Khafri S. Evaluation of audiological characteristics of patients with tinnitus referring to otolaryngology clinics of Babol. journal of babol university of medical sciences. 2016; 18 (1): 57-61.
10. Rudiger Heinrich, Ralph Feltens. Mechanisms underlying noise-induced hearing loss. Drug discovery today: disease mechanisms. 2006; 3(2):131-35.
11. Rahimpour, F, Mirzamohammadi E, Attarchi MS, Mohammadi S. Association between cigarette smoking and occupational noise exposure on hearing loss and hearing impairment. Journal of Baboluniversity of medical sciences. 2012; 14(1): 56-63.
12. Levy BS. Occupational and environmental health: recognizing and preventing disease and injury. 5th ed. Lippincott williams&wilkins; 2006.
13. Niskar AS, Kieszak SM, Holmes A, Esteban E, Rubin C, Brody DJ. Estimated prevalence of noise-induced hearing threshold shifts among children 6 to 19 years of age: the third national health and nutrition examination survey, 1988–1994, United States. Pediatrics. 2001;108(1):40-3.
14. Niskar AS, Kieszak SM, Holmes A, Esteban E, Rubin C, Brody DJ. Prevalence of hearing loss among children 6 to 19 years of age: the third national health and nutrition examination survey. JAMA. 1998;279(14):1071-5.
15. Ahmed HO, Dennis JH, Badran O, Ismail M, Ballal SG, Ashoor A, et al. Occupational noise exposure and hearing loss of workers in two plants in eastern saudiarabia.The annals of occupational hygiene. 2001;45(5):371-80.
16. Rachiotis G, Alexopoulos C, Drivas S. Occupational exposure to noise, and hearing function among electro production workers. Aurisnasus larynx. 2006;33(4):381-5.
17. Axelopoulos CG, Rachiotis G, Valassi M, Drivas S, Behrakis P. Under-registration of occupational diseases: the greek case. Occupational medicine. 2005;55(1):64-5.
18. Occupational safety & health administration. Occupational noise exposure: hearing conservation amendment (29 CFR 1910.95). National and regional offices state designees NIOSH regional program directors: The institute; 1981.
19. Hong OS, Kim MJ. Factors associated with hearing loss among workers of the airline industry in Korea. ORL-head and neck nursing: official journal of the society of otorhinolaryngology and head-neck nurses. 2001;19(1):7-13.
20. Toppila E, Pyykkö I, Starck J. Age and noise-induced hearing loss. Scandinavian audiology. Scandinavian audiology 2001;30(4):236-44.
21. Ferrite S, Santana V. Joint effects of smoking, noise exposure and age on hearing loss. Occupational medicine. 2005;55(1):48-53.
22. Rosenhall U, Pedersen KE. Presbycusis and occupational hearing loss.Occupational medicine. 1994;10(3):593-607.
23. Prince MM. Distribution of risk factors for hearing loss: implications for evaluating risk of occupational noise-induced hearing loss. The journal of the acoustical society of america. 2002;112(2):557-67.
24. Helmkamp JC, Talbott EO, Margolis H. Occupational noise exposure and hearing loss characteristics of a blue-collar population. Journal of occupational medicine. : official publication of the industrial medical association. 1984;26(12):885-91.
25. De Barba MC, Jurkiewicz AL, Zeigelboim BS, De Oliveira LA, Belle AP. Audiometric findings in petrochemical workers exposed to noise and chemical agents. Noise and health. 2005;7(29):7.
26. Osibogun A, Igweze I, Adeniran LO. Noise-induced hearing loss among textile workers in lagos metropolis. Nigerian postgraduate medical journal. 2000;7(3):104-11.