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Occupational Hearing Loss in Elementary School Teachers

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ABSTRACT

Background: *Regarding the noisy environment of schools and teachers' complaint of hearing loss, the present study was performed for the evaluation of occupational hearing loss in different elementary school teachers.*

Materials and methods: *Between 1995 and 2000, a case- control prospective analytical study was performed in Tehran city on 2000 elementary school teachers (case group) and 2000 individuals that were not teachers (control group).Both groups had similar age and sex. The age range was 25-55 yrs.*

The case group was selected from 10 educational districts of Tehran (1, 2, 5, 6, 9, 10, 13, 14, 17 and 18). The cases had no history of contact with confirmed hearing loss inducing factors. The control group had the same confounding variables as the case group. Evaluations were carried out in both groups by interview, making questionnaires, physical exam, pure-tone and speech audiometries; the results were recorded.

Results*: This survey showed that hearing sensitivity of the case group was lower than that of the control group (P<0.001) to different frequencies in both ears in regard to age, occupational history and working in different grades of elementary schools (grades 1 to 5). However, no significant difference was detected regarding hearing loss among the teaching grades and increased occupational history had no influence on this issue. Hearing loss was more significant in high frequencies (4 and 8 kHz) and was more prevalent in the latter (p<0.001).*

Conclusion*: Occupational noise exposure causes high-frequency sensorineural hearing loss. Thus, we recommend to measure intensity of noise in elementary schools and vocational technical schools in particular. In addition, hearing sensitivity level of students and teachers should be measured before the admission and employment, respectively. Annual regular audiometric examinations should also be performed for high-risk individuals and knowledge regarding complications of occupational noise exposure should be increased. As a conclusion, decreasing the number of students in each class, quiet classrooms, decreasing the hours of teaching and using hearing protection devices can prevent noise induced hearing loss.*
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Key words*: Hearing loss, Elementary School, Teacher*

INTRODUCTION

Hearing loss due to noise pollution has been recognized since a thousand years ago (1). Histology of this type of hearing loss was demonstrated for the first time by Haberman in 1890; Fowler also reported hearing loss in 400 Hz frequency (2).

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Although occupational hearing loss has been detected in places like factories (1, 2, 3, 4), schools have been ignored. This problem still exists in many countries as well. In a study by Allonen-Allie in 1990, sound level was measured in only one school among Massachusetts vocational-technical schools; sound intensity ranged from 72 to 110 dB in various places. About 338 students had noise exposure in each school for almost 30 h/ week (5).

Noise pollution can cause sensorineural hearing loss in high frequencies initially and (4) then, it may involve low frequencies gradually resulting in the involvement of speech frequencies. This defect may influence social relationships which is an important factor for the teachers in their occupation. It seems that prevention is the only effective way to overcome this problem (4).

The present study was performed in elementary schools of Tehran for evaluation of occupational hearing loss in teachers.

MATERIALS AND METHODS

Between 1995 and 2000, a case- control prospective analytical study was performed on 2000 teachers (case group) and 2000 individuals (control group) with age range of 25 to 55 years. The case group was selected randomly from elementary school teachers of various educational districts with occupational history from 3 to 22 years who were willing to cooperate in this survey. The cases were evaluated by interview, making questionnaire, physical exam, pure tone audiometry in frequencies of 250, 500, 1000, 2000, 4000 and 8000 Hz and speech audiometry including SRT, UCL and SDS. Individuals with confounding variables such as age> 55 years, occupational history of working in noisy environments, using ototoxic drugs, history of otologic diseases like tympanic membrane tearing, chronic purulent otitis media, otosclerosis, history of otologic surgery, vertigo, tinnitus, alcohol consumption, head trauma, allergy, family history of hearing loss, systemic disorders like hyperlipidemia, diabetes, hypertension, thyroid disorders, history of meningitis, brucellosis and mumps, were excluded.

The control group included individuals who were not teachers but were similar to the case group regarding confounding variables. They underwent similar audiometric exams as well.

Both groups were referred to a specific audiometry center.

The exam was planned as single blind in which audiologist was not aware of the identity of the subjects regarding being either a member of the case or the control group. All of the audiometric examinations were carried out by 2-Chanell device (model : Madsen, Intra-acoustic Company).

RESULTS

The case group included 1780 women (89%) and 220 men (11%) with mean age of 40.15 years (SD=± 5.84). The control group included 1760 women (88%) and 240 men (12%) with mean age of 40.58 years (SD=± 6.47). Among 2000 elementary school teachers, 340, 360, 440, 480 and 380 cases were in 1^{st}, 2^{nd}, 3^{rd}, 4^{th}, and 5^{th} grades, respectively.

It must be mentioned that some of the teachers had occupational history in different educational grades during their working period. In these cases, the grade related to the longest working period was considered.

The most important findings were as follows:

1. In the case group Hearing loss of both ears at different frequencies, based on age, was more significant than control group (table 1). Details were as follows:

- Age group of 25-30 years: hearing sensitivity levels in the case group at 250, 500, 1000, 2000, 4000 and 8000 Hz were 18, 20, 15, 18, 27 and 20 dB, respectively, in left ear and 20, 20, 18, 18, 20 and 14 dB, respectively, in right ear, being lower than those of the control group ($p< 0.001$).

Table 1. Hearing sensitivity levels of both ears for different frequencies, matched by age in case and control groups (1995-2000).

Age		Group	250 HZ		500 HZ		1000 HZ		2000 HZ		4000 HZ		8000 HZ	
			Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control
25-30	R	X	23.75	3.75	22.50	2.50	21.25	2.50	21.25	2.50	20.00	5.00	17.50	7.50
		SD	2.50	2.50	2.88	2.88	2.50	2.88	2.50	2.88	9.12	10.00	6.45	5.00
	L	X	22.50	3.75	22.50	2.50	21.25	6.25	21.25	2.50	18.75	5.00	22.50	6.25
		SD	2.88	2.50	2.88	2.88	2.50	6.26	6.29	5.00	4.78	7.07	5.00	4.48
31-36	R	X	26.17	7.14	25.88	5.00	25.30	5.72	22.05	4.28	18.52	9.28	26.76	11.42
		SD	5.70	4.87	5.65	5.77	5.14	7.32	5.01	7.86	5.52	7.86	11.71	8.02
	L	X	27.05	8.57	25.88	5.71	25.58	5.71	21.47	9.37	18.82	12.14	24.68	13.57
		SD	4.35	6.26	4.75	4.49	3.90	4.49	2.34	4.42	3.32	4.87	10.07	6.26
37-42	R	X	26.76	8.18	25.83	7.14	25.26	7.95	23.42	6.81	20.00	9.09	28.20	10.00
		SD	4.41	5.88	5.54	4.63	5.56	4.79	7.08	4.51	8.69	5.03	10.68	6.12
	L	X	26.85	6.81	36.35	6.13	25.81	7.50	22.63	6.81	20.00	11.81	28.03	10.68
		SD	5.95	4.51	3.35	4.06	5.95	5.29	6.23	5.46	7.62	6.05	10.04	6.60
43-48	R	X	26.80	7.73	25.89	6.81	25.53	8.50	22.85	8.18	20.71	11.36	31.25	13.63
		SD	4.63	4.10	4.52	4.62	4.78	4.74	4.98	6.43	5.03	7.10	12.52	7.44
	L	X	27.03	9.45	24.83	2.27	23.75	6.36	21.96	8.18	23.03	8.72	33.03	16.36
		SD	4.22	3.50	4.19	3.43	4.48	5.52	4.37	6.43	10.12	6.06	16.29	7.77
49-54	R	X	25.76	7.50	25.38	9.16	25.00	7.50	20.38	7.50	19.23	8.33	30.38	14.16
		SD	4.03	5.24	3.20	3.76	2.88	5.24	4.46	5.24	6.72	5.16	11.08	6.64
	L	X	27.30	10.00	25.00	6.66	24.23	7.50	19.61	7.50	18.07	9.16	30.00	14.16
		SD	3.30	4.47	2.88	2.58	2.77	6.89	1.38	4.18	4.34	3.76	13.69	6.46

- Age group of 31-36 years: hearing sensitivity levels in the case group at above-mentioned frequencies were 20, 20, 20, 12, 6 and 11 dB, respectively, in left ear and 19, 20, 20, 17, 9 and 15 dB, respectively, in right ear, being lower than those of the control group ($p<0.001$).
- Age group of 37- 42 years: hearing sensitivity levels in the case group at above-mentioned frequencies were 20, 30, 18, 15, 16 and 18 dB, respectively, in left ear and 18, 18, 17, 16, 11 and 18 dB, respectively, in right ear, being lower than those of the control group ($p<0.001$).
- Age group of 43- 48 years: hearing sensitivity levels in the case group at above-mentioned frequencies were 18, 30, 18, 15, 15 and 17 dB, respectively, in left ear and 19, 19, 17, 14, 9 and 18 dB, respectively, in right ear, being lower than those of the control group ($p< 0.001$).
- Age group of 49-54 years: hearing sensitivity levels in the case group at above-mentioned frequencies were 20, 18, 16, 12, 9 and 16 dB, respectively, in left ear and 18, 16, 17, 12, 17 and 16 dB, respectively, in right ear, being lower than those of the control group ($p< 0.001$).

2. In the case group, hearing loss for both ears, based on occupational history, was more significant than that of the control group. Details were as follows:

- Occupational history of 3-8 years (case group): hearing sensitivity levels in the case group at 250, 500, 1000, 2000, 4000 and 8000 Hz were 21, 22, 16, 17, 20 and 19 dB, respectively, in left ear and 21, 21, 17, 17, 19 and 11 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$; figure 1).

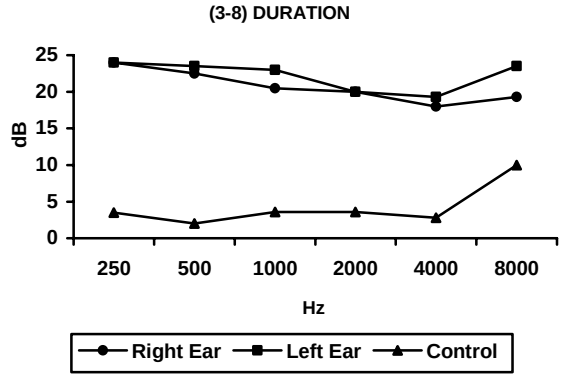

Figure 1. Hearing sensitivity levels of teachers with the occupational history of 3-8 years at different frequencies in both ears.

- Occupational history of 9-14 years (case group): hearing sensitivity levels of the case group at above- mentioned frequencies were 16, 17, 16, 12, 8 and 11 dB, respectively, in left ear and 14, 17, 17, 15, 11 and 14 dB, respectively, in right ear lower than those of the control group ($p< 0.001$; figure 2).

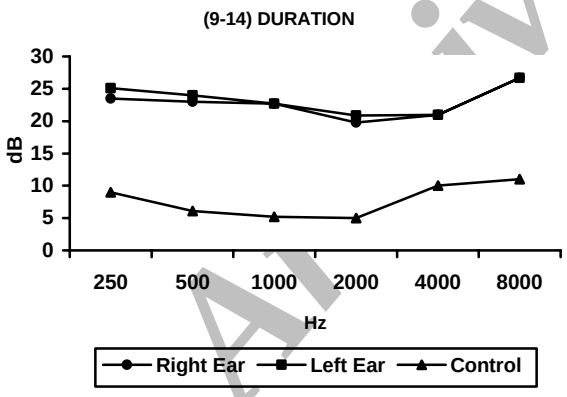

Figure 2. Hearing sensitivity levels of teachers with the occupational history of 9-14 yrs at different frequencies in both ears.

- Occupational history of 15-20 years (case group): hearing sensitivity levels in the case group for above- mentioned frequencies were 21, 19, 17, 16, 7 and 18 dB), respectively, in left ear and 18, 20, 18, 17, 11 and 21 dB, respectively, in right ears lower than those of the control group ($p< 0.001$; figure 3).

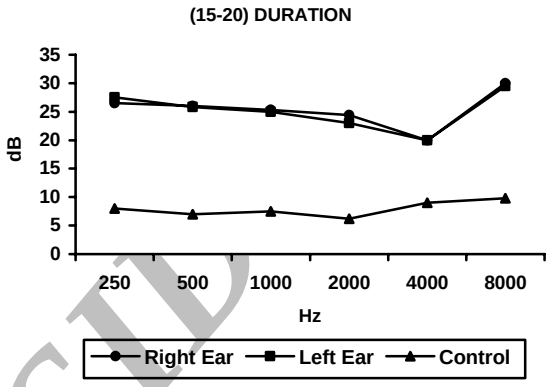

Figure 3. Hearing sensitivity levels of teachers with the occupational history of 15-20 years at different frequencies in both ears.

- Occupational history of 21-26 years (case group): hearing sensitivity levels in the case group at above- mentioned frequencies were 17, 18, 19, 10, 9 and 14 dB respectively, in left ear and 20, 20, 18, 15, 8 and 18 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$; figure 4).

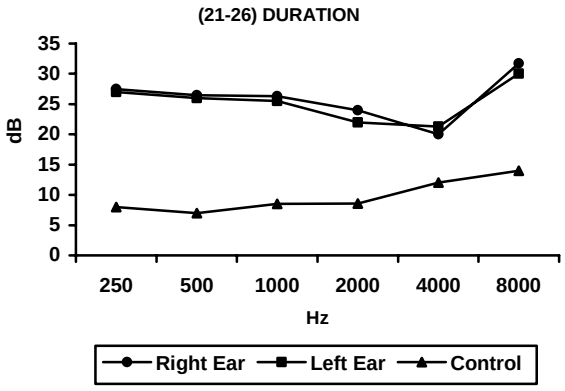

Figure 4. Hearing sensitivity levels of teachers with the occupational history of 21-26 years at different frequencies in both ears.

- Occupational history of 27-32 years (case group): hearing sensitivity levels in the case group at above- mentioned frequencies were 19, 19, 16, 12, 9 and 13 dB, respectively, in left ear and 19, 16, 14, 12, 10 and 10 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$; figure 5).

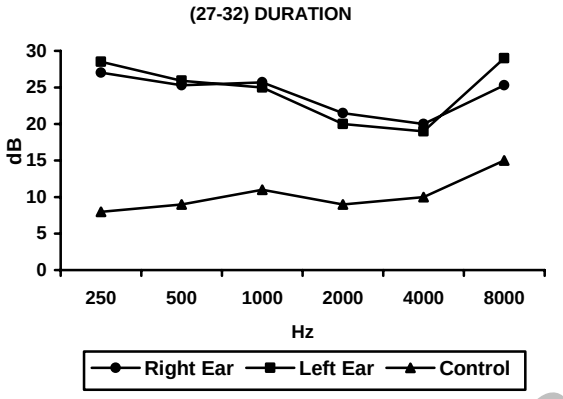

Figure 5. Hearing sensitivity levels of teachers with the occupational history of 27-32 years at different frequencies in both ears.

3. In the case group, hearing loss for both ears, based on different elementary school grades, was more significant than that of the control group (table 2). Details were as follows:

- First grade (primary school) (case group): hearing sensitivity levels in the case group at 250, 500, 1000, 2000, 4000 and 8000 Hz were 20, 19, 19, 13, 8 and 19 dB, respectively, in left ear and 18, 18, 17, 13, 9 and 19 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$).
- Second grade (case group): hearing sensitivity levels in the case group at above-mentioned frequencies were 21, 18, 10, 12, 7 and 18 dB, respectively, in left ear and 18, 17, 17, 15, 10 and 17 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$).
- Third grade (case group): hearing sensitivity levels in the case group at above-mentioned frequencies were 20, 20, 17, 14, 8 and 19 dB, respectively, in left ear and 19, 19, 19, 16, 12 and 20 dB, respectively, in right ear lower than those of the control group ($p< 0.001$).
- Forth grade (case group): hearing sensitivity levels in the case group at above- mentioned frequencies were 19, 21, 19, 16, 9 and 16 dB, respectively, in left ear, and 18, 11, 18, 16, 10 and 15 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$).
- Fifth grade (case group): hearing sensitivity levels in the case group at above- mentioned frequencies were 19, 19, 17, 13, 14 and 23 dB, respectively, in left ear and 16, 18, 15, 12, 13 and 16 dB, respectively, in right ear, lower than those of the control group ($p< 0.001$).

4. Hearing loss of the case group in high frequencies for both ears was more significant than other frequencies, as compared to the control group ($p< 0.001$). It must be mentioned that there was no significant difference in hearing sensitivity levels between the two ears. Therefore, the difference was compared between the two groups based on different elementary school grades in all frequencies for the left ear (figures: 6-10). As shown in these figures, hearing loss of teachers was more significant at 8000 Hz.

Table 2. Hearing sensitivity levels of teachers at different frequencies according to different elementary school grades in 4000 elementary school teachers and the control group in Tehran elementary schools of different districts- 1990-2001.

Class	Group		250 HZ		500 HZ		1000 HZ		2000 HZ		4000 HZ		8000 HZ	
			Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control	Teacher	Control
1	R	X	26.16	8.33	25.88	7.22	25	7.22	21.47	7.77	17.64	8.33	30.88	11.11
		SD	3.5	4.33	4.04	3.63	3.53	4.4	4.59	5.06	4.37	3.14	12.89	6
	L	X	27.05	6.11	25.26	6.11	25.58	6.11	22.05	8.33	20	11.66	30.58	11.11
		SD	3.97	4.16	4.13	3.33	3.9	4.16	4.69	5.59	6.12	4.33	13.67	6.5
2	R	X	27.22	8.33	25	7.22	25	7.22	22.22	7.77	18.88	8.33	28.33	11.11
		SD	4.91	4.33	5.42	3.36	5.14	4.4	4.91	5.06	5.3	3.14	9.23	6
	L	X	27.22	6.11	25	6.11	24.72	6.11	21.11	8.33	18.05	11.66	29.16	11.11
		SD	3.52	4.16	2.97	3.33	3.19	4.16	3.23	5.59	3.48	4.33	12.63	6.5
3	R	X	26.59	7.5	26.36	7.08	25.68	6.66	23.18	7.08	22.27	9.16	31.36	11.25
		SD	5.43	4.52	5.16	3.96	4.44	4.43	6.08	4.98	8.27	4.17	12.07	6.07
	L	X	27.95	7.08	25.45	5.41	24.09	6.25	21.13	6.66	20	11.25	29.09	10
		SD	4.27	4.96	4.34	3.34	3.97	4.33	3.75	5.77	6.17	4.33	10.76	6.03
4	R	X	26.27	7.5	18.33	7.08	25.21	6.66	23.12	7.08	19.16	9.16	26.04	11.25
		SD	3.36	4.52	7.17	3.96	5.41	4.43	7.63	4.98	8.8	4.17	10.53	6.07
	L	X	26.25	7.08	26.04	5.41	25.21	6.25	22.92	6.66	20.83	11.25	26.45	10
		SD	5.94	3.96	5.89	3.34	6.5	4.33	6.74	5.77	9.16	4.33	9.03	6.03
5	R	X	26.05	8.33	25.78	7.22	24.73	7.22	23.15	7.77	22.1	8.33	27.22	11.11
		SD	4.88	4.33	5.07	3.63	5.88	4.4	4.47	5.06	9.32	3.14	11.78	6
	L	X	25.52	6.11	25.52	6.11	23.68	6.11	21.32	8.33	25.52	11.66	34.21	11.11
		SD	5.98	4.16	5.5	3.33	5.97	4.16	4.03	5.59	13.93	4.33	17.89	6.5

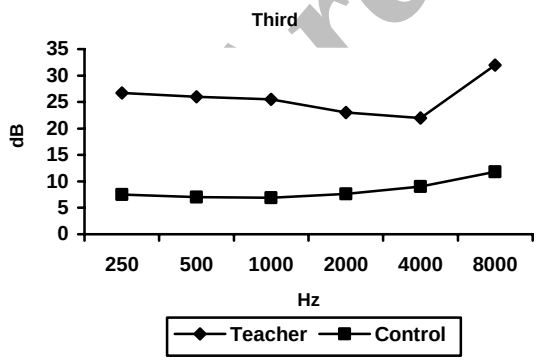

Figure 6. comparison of the hearing sensitivity level of the left ear of first grade teachers with the control group in all frequencies.

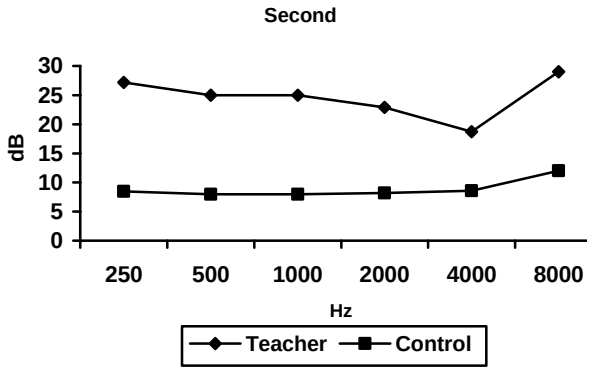

Figure 7. Comparison of the hearing sensitivity level of the left ear of second grade teachers with the control group in all frequencies.

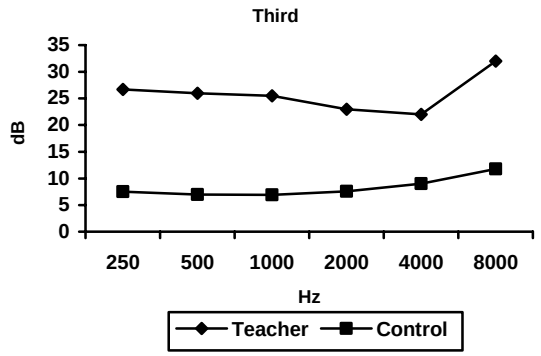

Figure 8. Comparison of the hearing sensitivity level of the left ear of third grade teachers with the control group in all frequencies.

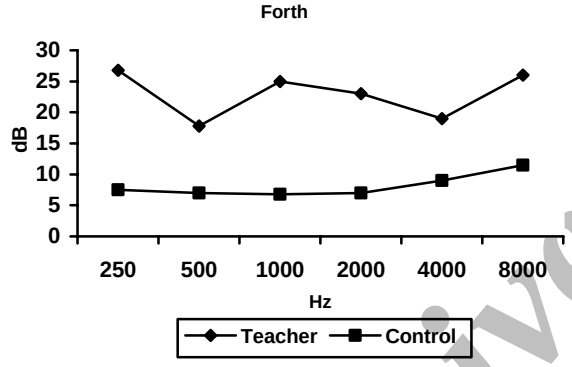

Figure 9. Comparison of the hearing sensitivity level of the left ear of forth grade teachers with the control group in all frequencies.

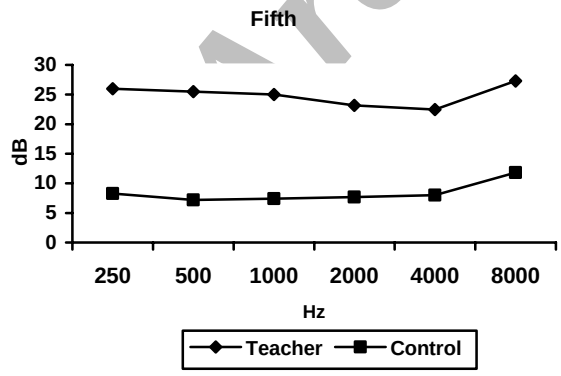

Figure 10. Comparison of the hearing sensitivity level of the left ear of fifth grade teachers with the control group in all frequencies.

DISCUSSION

In the year 2002, 19404 teachers worked in 1843 schools in Tehran (6). Occupational noise exposure is more common in the elementary schools and may cause high- frequency sensorineural hearing loss (1, 5). Noise- induced hearing loss has no treatment and the only effective way to overcome this problem is "prevention" (1, 2). In the other words, if the loud sound causes degeneration of internal ear ciliated cells, no effective drug has been produced for their regeneration (1, 2, 5). Thus, the importance of prevention is obvious (1, 2, 5, 7). Medical science has recognized noise-induced hearing loss many years ago (1, 2, 3, 4, 5). This problem has been detected in factories and industrial working places and attracted the employers and workers attentions to preventive methods for industrial working population (5, 7, 8, 9, 10). Furthermore, numerous studies have been carried out on farmers (7, 9, 11, 12) and lumber yard workers as well (8). However, no study has been performed in schools in Iran till now. Even in other countries, the reports on this issue are few (13, 14, 15). In a study by Allonen- Allie in 1990 (5), some questionnaires were sent to school principals of 27 educational districts of Massachusetts. The results indicated that sound intensity was measured only in one school ranged form 72 to 110 dB. About 338 students in each school spent almost 30 hours of their times in noisy environments per week. The study showed that the majority of teachers and students were at high risk of noise-exposure causing hearing loss. Thirty three percent of schools did not or rarely have hearing protective devices. In addition, most teachers and students had little knowledge about noise- induced hearing loss. Occupational history of teachers and the rate of noise induced hearing loss were not evaluated in this study. The obtained results were only based on analysing the answers to the questionnaires; additionally, no audiometric evaluation or case-control comparison was

performed.

The present study was performed in Tehran for the first time and showed that the mean hearing threshold was in normal range only in 2% of teachers and 73%, 24% and 1% had slight, mild and moderate hearing loss, respectively.

These persons did not have predisposing factors for sensorineural hearing loss. Speech reception threshold (SRT) of teachers and mean hearing threshold did not exceed from the standard limit (5 dB) indicating accuracy of pure-tone audiometry. Thus, speech hearing threshold was considered as statistical indicator in this study. We did not detect any significant difference among different elementary school grades. This may be due to impossibility of complete segregation of teachers in educational grades because of their frequent interchange between these grades even in one educational year.

Another important note is that no significant difference in hearing loss, based on occupational history existed between the two groups indicating no influence of this factor on their hearing loss. The reason may be due to maintaining a silent environment in the class by the teacher due to increased occupational history or decreasing teaching hours (i.e. avoid doing overtime work or participating in extra curricular activities).

In this study, left ear of the case group showed more significant hearing loss than right ear which seems unusual. However, in a study by Pirila et al. in 1991, this difference was not detected (16). There is no logical explanation for this finding in our study (5, 10).

Hearing loss in high frequencies (4 and 8 kHz) showed a more significant decrease compared to other frequencies. This was specifically more significant at 8 KHz ($p< 0.001$). We can conclude that teaching in an elementary school can cause noise- induced hearing loss in long term.

We recommend that sound intensity level should be measured in elementary and vocational technical schools. Moreover, it is suggested to increase knowledge of teachers and students about noise-induced hearing loss, decrease the number of students in each class, maintain a silent environment, decrease teaching hours, use hearing protection devices and other methods such as performing audiometry before employing the teachers and admission of students and finally, obtaining annual regular audiometry for them.

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