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ORIGINAL ARTICLE

Can teachers hear clearly? Investigating speech intelligibility and noise sensitivity in the classroom

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Abstract

Background Noise-induced hearing loss has the highest risk level among occupational hearing loss. One of the professions exposed to occupational noise is teachers.

Aims Our aim in this study was to evaluate speech intelligibility in noise and sensitivity to noise in teachers with normal hearing.

Methods Our study included 37 teachers and 37 healthy individuals from different professional groups, aged between 25 and 60, who were not diagnosed with hearing loss. All individuals included in the study administered a form including demographic characteristics, the Hearing in Noise Test (HINT), and the Weinstein Noise Sensitivity Scale by a single practitioner in a quiet room.

Results Comparing the speech in the Hearing in Noise Test and the Weinstein Noise Sensitivity Scale between the two groups, a statistically significant difference was found in the HINT and the WNSS scores of the teachers compared to the control group ($p<0.05$).

Conclusion When the HINT test and noise sensitivities of teachers and individuals from other professional groups were evaluated, it was determined that although teachers have normal hearing, they have difficulty understanding speech in noisy environments and are sensitive to noise. Teachers' working environments should be arranged, and studies should be carried out for hearing health to reduce their professional effects.

Keywords Occupational hearing loss · Teacher · Noise · Hearing in noise test · Weinstein noise sensitivity scale

Introduction

Environmental noise is a major occupational risk factor that can negatively impact workers' physical and psychological health. Occupational noise-induced hearing loss (ONIHL) is the most common work-related disease and accounts for 16% of adult hearing loss [1]. In occupational hearing loss, the risk of hearing loss increases directly to age, noise level, and duration of noise exposure [2]. Occupational noise-induced hearing loss (ONIHL) can lead to difficulties in communication, social stress, sadness, lack of self-confidence, and difficulties in personal relationships and communication [3].

Occupational noise-induced hearing loss has increased dramatically in recent years but there are limited studies on occupational noise-induced hearing loss and its effects on teachers despite their exposure to classroom noise and different noises at school [4]. Not only the function of the auditory system but also auditory functioning, speech intelligibility, sound localization, and speech intelligibility in noise are of occupational importance for teachers. Teachers' ability to understand speech and sounds and respond appropriately in a noisy environment depends on their cognitive and auditory performance [4, 5].

The ability of teachers to fulfill their occupations comfortably and adequately is related to individual performance, motivation, and environmental conditions. The environmental conditions of teachers, the most affected occupational group, are essential for their performance. In

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line with this information, our study aims to evaluate the effect of noise on speech comprehension, which affects the occupational performance of teachers.

Materials and methods

Individuals aged between 25 and 60 years who are teachers in different branches and from other occupational groups were included in our study. According to the power analysis result (95% power, $\alpha=0.05$, $\beta=0.20$), a total of 74 people were determined as 37 teachers and 37 controls.

Lokman Hekim University medical and health sciences research board approved the study (2024/106). This study was conducted in accordance with the Declaration of Helsinki Principles. Each participant was informed about the study and signed an informed consent form.

The inclusion criteria for the study were being between 25 and 60 years of age, having normal hearing thresholds below 20 dB on audiological evaluation (pure-tone average at 500, 1000, 2000, and 4000 Hz), not having a diagnosis of hearing loss, not using hearing aids, and, for teachers, having been actively teaching for at least 5 years.

All individuals included in the study were administered a form including demographic characteristics, the Hearing in Noise Test (HINT), and the Weinstein Noise Sensitivity Scale (WNSS) by a single practitioner in a quiet room.

The hearing in noise test (HINT)

The Hearing in Noise Test (HINT) assesses an individual's ability to understand speech in noisy environments. It involves repeating sentences presented with background noise through speakers at different angles. The test is computer-based, easy to apply across age groups, and has been validated in multiple languages [6]. The HINT test has been validated and is reliable in different languages. It is an easy and applicable computer-based assessment method for various age groups.

The adaptive version of the HINT test for adults was used in this study. This version consists of a list of 20 Turkish sentences and presents a different list of sentences for each person. The test starts with a 65 dB signal and 65 dB noise. The individual is asked to repeat the sentence, and the signal-to-noise ratio changes according to the answer. As the individual answers the question correctly, the SNR decreases by -4 dB, and as the individual answers incorrectly, the SNR increases by +4 dB. Each word he/she hears during the test has a separate score, and he/she receives points for each word he/she says correctly. At the end of the test, the software program automatically calculates the signal-to-noise ratio and the individual's test score. This score is calculated as a percentage.

Prior to each test session, device calibration was performed. Before the test, the ambient noise level was measured using a sound level meter, and the obtained value was recorded as the environmental noise level in accordance with the HINT test protocol. In the HINT procedure, the location of the speech source (one of the speakers) was fixed at 1 m directly in front of the participant at head level for all test conditions, while the noise source was (one of the speakers) positioned at a 90° azimuth on the right side, also at head level and 1 m from the center of the participant's head. The test was applied by repeating the words heard by the individual. Separate recordings were made for all individuals.

Weinstein noise sensitivity scale (WNSS)

Noise sensitivity varies between individuals, making it difficult to measure. The Weinstein Noise Sensitivity Scale (WNSS), a validated and reliable 21-item Likert-type scale, is widely used for this purpose. It asks individuals to rate their agreement with statements, and higher scores indicate greater noise sensitivity [7].

Statistical analysis

SPSS (Statistical Program For Social Sciences) 25.0 version was used for statistical analysis. Continuous variable statistical program calculations were made using mean ± standard deviation (XSS) for numerical data and variables determined by counting. A comparison of the means of the numerical data between the groups was performed with the "student t-test." A p-value less than 0.05 was considered statistically significant.

Results

Our study included 74 participants, 37 of whom were teachers in different branches and 37 of whom were non-teachers (control group). The mean age of the teachers included in the study was 42.94 ± 8.65 years, and the mean age of the control group was 38.89 ± 10.28 years. Among the teachers included in the study, 30 were female (81.1%) and 7 were male (18.9%), while 24 were female (64.9%) and 13 were male (35.1%) in the control group. A comparison of the working years of the teachers revealed that 40.5% of the teachers included in the study had worked between 5 and 15 years, 27% between 16 and 25 years, and 29.7% 26 years or more. When all individuals included in the study were evaluated audiologically, they had normal hearing with average

Table 2 Comparing HINT and WNSS between the two groups

Group test	Teachers group	Control group	*P* value
HINT	76.06 ± 11.78	96.18 ± 5.69	0.000*
WNSS	100.35 ± 11.23	88.40 ± 12.21	0.000*

Table 1 Socio-demographic characteristics of participants

		Control group	Teachers group
Age (years)		38.89 ± 10.28	42.94 ± 8.65
Gender (%,n)	Female	%64.9 (24)	%81.1 (30)
	Male	%35.1 (13)	%18.9 (7)
Hearing Threshold (dB)		6.51 ± 1.07	8.94 ± 5.96
Occupation	Speech-Language Pathologist	%10.8 (8)	
	Physical therapist	%5.4 (4)	
	Psychologist	%10.8 (8)	
	Housewife	%9.5 (7)	
	Secretary	%10.8 (8)	
	Doctor	%2.7 (2)	
	Teacher		%50 (37)

hearing thresholds (500- 1000-2000–4000 Hz) in the range of 0–20 dB. The mean hearing threshold was determined to be 8.94 ± 5.96 dB in the teacher group and 6.51 ± 1.07 dB in the control group. No statistically significant difference was found between the two groups ($p = 0.203$).

Comparing the speech in the Hearing in Noise Test (HINT) and the Weinstein Noise Sensitivity Scale (WNSS) between the two groups, a statistically significant difference was found in the HINT and the WNSS scores of the teachers compared to the control group ($p < 0.05$) (Table 2.).

Discussion

Teachers are among the professions most affected by noise-induced hearing loss, which impacts their hearing, speech comprehension, and quality of life. This study evaluated teachers' noise sensitivity and their ability to understand speech in noisy environments. The results showed reduced speech comprehension and increased noise sensitivity among teachers exposed to occupational noise.

Prolonged exposure to noise levels of 85 dB(A) or above may result in temporary/permanent hearing loss, tinnitus, or difficulty understanding speech in a noisy environment [8]. The exposure limit for noise-induced hearing loss is 85 dB A for 8 h [9]. One of the areas where noise is common is education centers. Classrooms, corridors, gardens, and social areas are evaluated in measurements made with sound level meters, and different noise levels have been determined. In studies carried out in different countries, the classroom noise level in London is approximately 65 dB(A), the corridor noise during recess is 72 dB(A) [10], the classroom noise level in Brazil is 60 dB(A) and above [11], the classroom noise level in Hong Kong is 67–70 dB(A) [12], while in studies conducted in Europe and America, the noise level in schools was reported to be between 53 and 72 dB(A) [10]. As a result of the measurements we made in different parts of the school with a sound level meter in our study, it was found that the noise level in the classroom was 62 dB (A), the noise level in the corridor during recess was 86–90 dB (A), and the noise level in the school garden was between 80 and 100 dB (A). The in-school noise level we obtained is similar to other studies and is determined to be at the noise exposure level. Thus, considering the working conditions of teachers for a long time, it was determined that teachers work in noisy environments and carry occupational risks. In hearing loss in teachers, the severity of hearing loss is related to the intensity/duration of noise exposure and years of occupation [13]. Our study group consisted of individuals who have been teaching for at least 5 years to evaluate the effects of teachers' working conditions in noisy environments.

Although there are studies on teachers, an occupational group affected by noisy environments, in different fields, no study on speech distinction in noise and sensitivity to noise has been found in the literature. In a study conducted on teachers working in a noisy environment, it was found that although they had normal hearing, there was a difference in signal-to-noise ratios in DPOAE measurements performed at the end of the day and after rest. It has been reported that noise levels of 60 dB (A) and above in the teachers' environment may cause damage to the cochlea [14]. Although the teachers included in our study have normal hearing, the noise level of their environment above 60 dB (A) poses a risk for occupational hearing loss. Social and individual precautions should be taken for teachers to cope with noise and to protect them from occupational discomfort.

The noise level in schools and classrooms causes psychophysiological stress on teachers and poses a cardiovascular risk, and vocal cord problems occur due to loud speaking [15]. Difficulty in understanding speech due to hearing loss has been found to make it difficult for teachers to perform their occupation and cause a decrease in their performance. Uysal et al. reported that noise-induced damage to the cochlea occurred in teachers and that they had no sound tolerance [16]. Age and noise exposure pose a risk for teachers. Bitar et al. reported sensorineural hearing at certain frequencies (3, 4, and 6 kHz) in 30% of teachers [17]. Direction determination and speech intelligibility are impaired in high-frequency hearing loss [18]. Different studies have been conducted in the literature on teachers with high noise exposure levels. Still, no study has been

found on speech intelligibility in noise, which is one of the effects of hearing loss. In addition to hearing loss, one of the most common problems experienced by teachers is difficulty in understanding speech in noise and sensitivity to noise. In our study, we evaluated the Hearing in Noise Test (HINT) and sensitivity to noise in teachers who were not diagnosed with hearing loss. We found that teachers had difficulty understanding speech in noisy environments and were sensitive to noise.

While noise is one of the high-risk factors for teachers in terms of occupational health, the measures taken in schools are insufficient. By considering the noise level and its effects, the arrangement of classroom environments and materials used in the classroom, garden, and school environment should minimize the possible hearing loss and its impact.

Teachers working in noisy environments should determine the ambient noise levels using mobile phone applications and, when necessary, use protective earplugs to avoid noise exposure. By undergoing regular hearing assessments, early detection of potential hearing loss due to noise exposure can be ensured, allowing for appropriate treatment planning.

Conclusions

Consequently, to protect the hearing health of teachers exposed to occupational noise and to minimize the adverse effects that may be seen, we think that regular audiological evaluations should be performed, arrangements should be made to reduce noise in schools and public awareness should be raised, necessary precautions should be taken, and more studies should be carried out on the subject.

Declarations

Competing Interests The authors of the manuscript must declare that there are no conflicts of personal and financial interest within the scope of the study.

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