The effect of occupational exposure to noise and chemical agents on hearing abilities

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Introduction

Noise causes loss of inner and outer hair cells in the cochlea, decreased blood flow in the basal region, rupture of cell connections, excitotoxicity and loss of VIII nerve fibers, and cochlear synaptopathy. Exposure to loud noise may cause hearing disorders such as tinnitus, recruitment, and hyperacusis in addition to hearing loss [1]. While noise accounts for the majority of occupational hearing loss, occupational chemical agent exposure is also a risk factor for hearing loss [2]. Among the many chemicals found in the environment, the chemicals most known to cause ototoxicity are organic solvents such as toluene, styrene, xylene, and ethyl benzene, and exposure to these chemicals can significantly impair the auditory system [1].

Millions of workers are exposed to noise at work every day, and uncontrolled noise exposure can cause permanent hearing loss. Hairdressers are also among the occupational groups routinely exposed to these risk factors. Hair dryers used frequently and in large numbers in hairdressing salons can produce unwanted sounds between 60-95 dB. Noise from hair dryers can be harmful to human health and especially auditory function, as it is usually used very close to the ear [3]. However, it has been reported in the literature that chemical agents in the working environments of hairdressers also cause negative health effects. Especially in some hairdressing salons, high concentrations of chemicals have been discovered. It has been reported that these chemicals found in hairdressing salons contain volatile solvents, cetrimonium chloride, toluene, ethyl benzene, betaine monohydrate, ammonia compounds, cyanoacrylates, formaldehyde, methacrylate, nitrosamines, etc. [4]. Exposure to these chemicals, which are found in hair dyes, lightening agents, permanent wave solutions, shampoos, conditioners, and hair styling products, can have acute or chronic health effects. Some studies have reported that hairdressers are at increased risk for certain health problems, including asthma, rhinitis, hypersensitivity pneumonia, and decreased lung function. There are also studies reporting that chemicals in hair products are potentially carcinogenic and that hairdressers are more likely to develop lung, larynx, and bladder cancer.

Objective

When the literature was reviewed, many studies were found in which occupational diseases in hairdressers were investigated. However, no study has been found that primarily aims to evaluate the hearing function of hairdressers, who are often exposed to noise and chemical agents that may threaten hearing health in their working environments. For this reason, we aim to evaluate the possible effects of noise and chemical agents on the auditory system of hairdressers.

Methodology

This research was conducted in the Audiology Clinic of Bezmialem Vakif University and it was approved by the Bezmialem Vakif University Non-Interventional Research Ethics Committee on 07 February 2023 (decision number: 2022/407). We reached the heads of hairdresser associations, and they helped us with data collection by communicating with hairdressers on their social media accounts. For the control group, we reached participants via the researchers' social media accounts. In the study group, 109 people filled out the form, but 9 people were excluded from the study due to hearing loss onset before the hairdressing profession and working in another occupation where noise/chemical agents were present before the hairdressing profession. In the control group, 135 people filled out the form, but 35 were excluded from the study due to noise/chemical agent exposure in their current and/or previous working life. One hundred participants from the study group (min-max; 25-57 years) and one hundred participants from the control group (min-max; 25-56 years) who met the inclusion criteria were included.

Qualities of Hearing Scale (SSQ) transmitted to woman's hairdressers (study group), and non-hairdresser or nonworker individuals (control group) via Google Forms. SSQ scale was developed by William Noble and Stuart Gatehouse in 2004 at MRC Institute of Hearing Research, Glasgow, UK, to evaluate the sub-components of hearing and hearing quality in detail and to determine the level of disability caused by the current hearing problem [5]. It was adapted into Turkish, and its validity and reliability study were conducted by Kılıç et al. (2021) [6]. The SSQ scale evaluates the reality of hearing in daily life in a wide range. The SSQ consists of the sub-headings of speech perception, spatial perception, and hearing quality and is a 10-point Likert scale with 14, 17, and 18 questions, respectively, with a total of 49 questions. Basically, it aims to evaluate the parameters of hearing speech sounds in various conditions, direction, distance, and movement components of spatial perception, distinguishing sounds in simultaneous speech, ease of listening, the naturalness of voice, clarity and identifying different speakers, different musical pieces and instruments, different everyday sounds [5].

Results

Demographic data of the study and control groups are shown in **Table 1**. There was no significant difference between the groups in terms of age and gender.

Transactions performed by hairdressers in the hair salons, the average daily exposure to noise/chemical agents, the questions about the work environment, such as at least how many hair dryers are working at the same time, and hairdressers' complaints after working hours are shown in **Table 2**.

The auditory complaints of the study and control groups were questioned, and the percentage values of the answers are shown in **Table 3**.

Table 1. Demographic data of groups

Demographic data	Study group		Control group	
Age (mean ± sd)	40.96 ± 7.76		39.29 ± 7.99	
Gender	52F/48M		58F/42M	
Working time (year)	Year	n/%	Year	n/%
	1-3	10	1-3	27
	3-5	3	3-5	18
	5-10	5	5-10	16
	>10	82	>10	29
			Nonworker	10
Weekly working time (day/week)	Day	n/%	Day	n/%
	5-6 days	83	1-2 day	2
			3-4 day	6
	7 days	17	5-6 day	82
			0 day	10
Daily working time (hour/day)	Hour	n/%	Hour	n/%
	5-8 hour	11	0-4 hour	2
			5-8 hour	58
	>8 hour	89	>8 hour	30
			0 hour	10
Exposure to non-working noise (listening to loud music)	Yes (n/%)	No (n/%)	Yes (n/%)	No (n/%)
	17	83	45	55

Table 2. Work environment status and after-hours complaints of the study group

Transactions	Transaction	n/%						
	hair dyeing	17						
	hair drying	5						
	hair dyeing + permanent hair styling	3						
	hair drying + permanent hair styling	1						
	hair drying + hair dyeing	2						
	hair drying + hair dyeing + permanent hair styling	72						
Minimum number of hair dryers working simultaneously	number	1	2	3	4	5	6	7
	n/%	33	39	3	18	1	3	3
Average daily exposure to hair dryer (hours/day)	hour	<1h	1-2h	3-4h	5-6h		7-8h	>8h
	n/%	1	1	3	3		11	12
			13	2				
Average daily exposure to chemical agents (hours/day)	hour	<1h	1-2h	3-4h	5-6h		7-8h	>8h
	n/%	5	12	2	2		10	16
			28	9				
Do you find it difficult to communicate with others when there is noise in the work environment?	Undecided	20%						
	Yes	54%						
	No	26%						
Do you feel tinnitus/buzzing after work?	Yes (n/%)	No (n/%)						
	41	59						
Do you feel a decrease in your hearing after leaving work?	22	78						

Table 3. Auditory complaints of the study and control group

Complaints	Study Group (n/%)		Control Group (n/%)	
Tinnitus	Bilateral	20	Bilateral	4
	Right	5	Right	1
	Left	3	Left	2
	No complaints	72	No complaints	93
Hearing loss	Bilateral	12	No hearing loss	
	Right	6		
	Left	7		
	No hearing loss	75		
Difficulty understanding speech in noise	Yes	No	Yes	No
	64	36	24	76

Table 4. Comparison of SSQ sub-dimensions and general score by groups

Dimension	Group	n	mean/sd	P
Speech	Study	96	6.24 ± 2.26	<0.001
	Control	97	8.01 ± 1.37	
Spatial	Study	87	6.84 ± 2.37	<0.001
	Control	99	8.60 ± 1.17	
Qualities of Hearing	Study	90	7.97 ± 1.88	<0.001
	Control	94	9.22 ± 0.86	
SSQ	Study	81	7.02 ± 1.96	<0.001
	Control	90	8.62 ± 1.00	

When the results of the study and control groups were compared, a statistically significant difference was found between the two groups in speech perception, spatial perception, hearing quality, and general SSQ scores. The scores of the study group were found to be significantly lower in all sub-dimensions and general scale scores (P<0.001). The value of the scale dimensions of both groups is shown in **Table 4**.

Discussion

In our study, the effect of exposure to noise and chemical agents on the auditory system in hairdressers was evaluated with the SSQ scale, and as a result of the study, it was determined that speech perception, spatial perception, and hearing quality were significantly lower in hairdressers than in the control group.

OSHA allows up to 8 hours of exposure to 90dB(A) noise, but it is estimated that 22 million workers are exposed to potentially damaging noise in the workplace each year [7]. According to OSHA, if we have to speak louder to talk to someone one meter away, the noise level in our environment can be over 85 dB. Also, if we experience tinnitus, buzzing, or temporary hearing loss when we leave work, and we have to shout to be heard by a colleague an arm's length away, we may have a noise problem in our workplace]. 54% of the hairdressers who participated in our study stated that they had difficulty communicating with others when there was noise in the working environment. In addition, after leaving work, 41% of hairdressers reported that they felt tinnitus/buzzing, and 22% reported that they felt a decrease in their hearing. The data we obtained supports OSHA's warning and shows that noise is a problem in the working environments of hairdressers.

Most of the equipment used in the hairdressing and cosmetics industry can typically generate noise above the permissible limit in the workplace. Since hairdressers from every region of the country were included in our study, it was impossible to measure the noise level of hair salons. However, we questioned how many hair dryers are working simultaneously. 39% of the hairdressers reported that at least 2 hair dryers worked simultaneously daily. Hair dryers produce sound in the 60-95dB range, and such high noise levels can potentially lead to noise-induced hearing loss (NIHL). In addition, when more than one noise source works simultaneously, this effect on the environment is multiplied. For example, when two sound sources producing 90 dB work together, the sound level will increase to 93 dB, and when 3 sound sources work together, the sound level will increase to 95 dB [8]. Also, 88% of the hairdressers reported that the average daily hair dryer exposure was 3-4 hours or more, and 12% reported exposure to hair dryer noise for more than 8 hours a day. Considering that OSHA allows 90 dB noise exposure for a maximum of 8 hours and 95 dB noise for a maximum of 4 hours, it is inevitable to observe the adverse effects of noise in hairdressers. In addition, proximity to the noise source is also known to increase the damaging effect, and for individual use, the hair dryer is usually operated at a distance of 1 to 6 inches [9].

Noise is present in most occupational environments therefore hearing impairments observed among workers are often referred to as NIHL. However, in addition to noise, ototoxicity is one of the important factors that cause hearing loss in hairdressers [10]. Research shows that exposure to certain chemicals, called ototoxic, can adversely affect the functioning of the ear, independently of noise exposure, causing hearing loss and/or balance problems. Chemical agents have been reported to damage cochlear hair cells and peripheral nerve endings, and their effects are not limited to the cochlea. Reports have shown that retrocochlear and central effects may also be associated with these exposures. Since chemical agents can affect the central auditory system, frequency, temporal and spatial resolution, and speech discrimination function may be affected. This can make it difficult to work in noisy environments and increase the risk of workplace injury due to the inability to hear co-workers, environmental sounds, and warning signals. Compared to other disability questionnaires, the SSQ focuses specifically on perceiving speech sounds in various competing contexts and on the direction, distance, and movement components of spatial hearing. In addition, the SSQ evaluates the separating sounds, participating in simultaneous speech flows, recognizing different sounds, and ease of listening. Central auditory attention and cognitive factors get involved in these hearing-speech abilities. Banh et al. (2012) observed a decrease in SSQ scores in the hearing loss group compared to individuals with normal hearing in the same age group [11]. In another study, Demeester et al. (2012) compared SSQ scores in different age groups with normal hearing and observed that SSQ scores decreased with age [12]. The results of these two studies show that the SSQ is affected by cochlear and retrocochlear disorders and increasing age. In this context, our study confirmed that chemical agents and noise exposure affect auditory performance via a significant decrease in SSQ scores.

Studies show that exposure to chemical agents in hairdressers makes them sensitive to hearing loss. Cosmetic products are indispensable products for hairdressing salons. They can contain up to nine thousand different ingredients, and hundreds of them are used in hairdressing salons. These products include shampoos, conditioners, hair dyes, and various sprays, which often contain a mixture of several different chemicals. Hairdressers contact with hair care products daily and are exposed to potentially hazardous chemicals through inhalation and/or skin contact. Although contact with these chemicals in hair products is usually short-term, hairdressers' exposure rate is high. Chemicals commonly found in hair salons include volatile organic chemicals such as formaldehyde, ammonia, ethanol, aromatics, esters, ketones, terpenes, and contact allergens such as limonene. Styrene, benzene, toluene, ethylbenzene, potassium or sodium bromate, and thioglycolates that is reported ototoxic effects, and are also chemicals that can be found in hairdressing salons.

To summarize, hairdressers are generally exposed to noise and chemical agents for a long time in their working environments. It was determined in our study that hairdressers had auditory complaints and adverse effects on their auditory performance however, it is important to evaluate the auditory systems of hairdressers with a broader test battery in future studies. In addition, improvements such as the use of protective equipment, working hours regulation, and ambient ventilation may be beneficial in terms of eliminating the factors that may threaten the hearing health of hairdressers.

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