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Characterization of hearing profile of gas station attendants

Caracterização do perfil auditivo de frentistas de postos de combustível

Fernanda Zucki[1], Lilian Cássia Bórnia Jacob Corteletti[1], Miriam Harumi Tsunemi[2], Graziela Simeão Munhoz[1], Isabela Alves de Quadros[1], Kátia de Freitas Alvarenga[1]

ABSTRACT

Introduction: Researches into populations with low solvent exposures, or exposures within tolerance levels allowed in the occupational field are still restricted. **Purpose:** To characterize the hearing profile of gas station attendants. **Methods:** Cross-sectional study, constituted of two groups, matched by gender and age: Control Group - 23 subjects without exposure to noise or chemicals; Experimental Group - 21 gas station attendants. An audiological evaluation was performed, composed by pure tone audiometry, speech audiometry and acoustic impedance tests. The statistical analysis used average calculation, standard deviation, minimum and maximum value; Chi-square Test and Pearson's correlation coefficient. The significance level was 5%. **Results:** Hearing loss was verified in gas station attendants characterized by impairment of the peripheral auditory system, suggesting toxic effects of exposure to fuels. There was a correlation between age and solvent exposure time. Comparing the groups, the acoustic reflex showed more alterations in the experimental group, with a difference for the ipsilateral acoustic reflexes of the right ear and contralateral ones of the left ear. **Conclusion:** There was no difference between the groups for the hearing thresholds; however, the difference observed in the ipsilateral and contralateral acoustic reflexes in the experimental group suggests retrocochlear impairment. Due to the evidence observed in this study, it is considered relevant to include the acoustic reflex research in the auditory evaluation of the gas station attendants, as well as the integration of this professional category into hearing loss prevention programs.

Keywords: Hearing; Gasoline; Solvents; Occupational exposure; Chemical compound exposure

RESUMO

Introdução: Pesquisas voltadas para as populações com baixas exposições a solventes, ou exposições dentro dos níveis de tolerância permitidos em âmbito ocupacional ainda são restritas. **Objetivo:** Caracterizar o perfil auditivo de frentistas de postos de combustíveis. **Métodos:** Estudo transversal, constituído por dois grupos, pareados por gênero e idade: Grupo Controle - 23 indivíduos sem exposição a ruído ou agentes químicos; Grupo Experimental - 21 frentistas de postos de combustíveis. Foi realizada avaliação audiológica, composta por audiometria tonal liminar, logoaudiometria e medidas de imitância acústica. A análise estatística utilizou cálculo de média, desvio padrão, valor mínimo e máximo, teste Qui-quadrado e coeficiente de correlação de Pearson. O nível de significância adotado foi de 5%. **Resultados:** Foram verificadas alterações auditivas nos frentistas, caracterizadas por comprometimento no sistema auditivo periférico, sugerindo ação tóxica da exposição a combustíveis. Houve correlação entre idade e tempo de exposição a solvente. Na comparação entre os grupos, o reflexo acústico demonstrou maior número de alterações no grupo experimental, com diferença para os reflexos acústicos ipsilaterais da orelha direita e contralaterais da orelha esquerda. **Conclusão:** Não houve diferença entre os grupos para os limiares auditivos, porém, a diferença verificada nos reflexos acústicos ipsilaterais e contralaterais no grupo experimental sugere comprometimento retrococlear. Diante das evidências observadas neste estudo, considera-se relevante incluir a pesquisa do reflexo acústico na avaliação auditiva dos frentistas, bem como a integração desta categoria profissional aos programas de prevenção de perda auditiva.

Palavras-chave: Audição; Gasolina; Solventes; Exposição ocupacional; Exposição a produtos químicos

Study conducted at the Speech Pathology Department, Bauru School of Dentistry, Universidade de São Paulo – USP – Bauru (SP), Brazil.
(1) Speech Pathology Department, Bauru School of Dentistry, Universidade de São Paulo – USP – Bauru (SP), Brazil.
(2) Biostatistics Department, Universidade Estadual Paulista Júlio de Mesquita Filho – UNESP – Botucatu (SP), Brazil.
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Corresponding author: Fernanda Zucki. E-mail: fernandazucki@hotmail.com
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INTRODUCTION

Clinical and experimental studies have been conducted by the scientific community, with the purpose of understanding the relationship between the chemical compound exposure and the auditory system, identifying possible substances that are protective to the toxicity of these compounds, as well as suggesting preventive measures. The studies related to solvent ototoxicity have concentrated on populations who present high exposures, in industrial environments, whose ototoxic and neurotoxic effects were already demonstrated. Besides, experimental studies have confirmed, considerably, the biological processes involved in this toxic action[1]. However, the investigations concerning the populations with low solvent exposures, or exposures within tolerance levels allowed in the occupational field, as in the case of the gas station attendants, are still restricted[2,3,4].

Petroleum is a complex mixture containing several compounds, mostly represented by hydrocarbons. The compounds of interest that require greater environmental concern are: benzene, toluene, ethylbenzene and xylene. These compounds, known as BTEX, are defined as monoaromatic hydrocarbons, whose molecular structures are primarily characterized by the presence of a benzene ring. They are mainly used in solvents and fuels, being the most soluble constituents of the gasoline. They are toxic compounds both for the environment and human being, depressing the central nervous system and presenting chronic toxicity[5].

Besides the fuel (solvent mixture), there are inumerous risk agents to which the gas station attendants are exposed, as the noise pollution and air pollution, being all of them potentially harmful to health, including the auditory one. It is known that the site of the lesion, the mechanisms and the extension of the disorder caused by these agents may vary, according to the type of contaminant, interactions with other ototoxic agents, concentration and period of exposure[6].

Solvent-induced hearing loss is considered a complex disease, which can be originated by the combination of ototoxicity and neurotoxicity, differing, thus, from the deleterious effects of the noise, in the hearing[7]. The evaluation of these deleterious effects of the organic solvents in human being becomes even more difficult, since that, in experimental studies, much higher solvent concentrations are used. Besides, the workers are, many times, exposed to a mixture of solvents with different chemical structures and different concentrations, as well as they are simultaneously exposed to the noise[8].

Considering the evidences of animal studies on the ototoxic properties of the organic solvents which compose the gasoline, the exposure of gas station attendants to the solvent mixture, and the shortage of studies on the possible side effects of ototoxic exposures in populations of workers who are out of the industrial environment, the present study proposes characterizing the audiological profile of gas station attendants.

METHODS

This study was approved by the Committee of Ethics in Research of Bauru School of Dentistry, *Universidade de São Paulo*, under the number 893.513, on 11/26/2014.

Data was collected in the speech pathology clinic in the same institution, with the express agreement of the subjects chosen, who were informed about the research and signed the Informed Consent Form.

Sample selection

By the Workers Health Referral Center (collaborator agency) and the speech pathology clinic of the institution proponent of the research, the purpose of the study was presented to the gas station managers, the university students of the same course and members of the local community. The subjects interested to participate, after having a contact with the researchers, were selected using the following exclusion criteria:

- For the Control Group: past history or current occupational exposure to the noise or another agent that is toxic to the auditory system; chronical alterations in the middle ear and/or the presence of air-bone gaps in the pure tone audiometry; type B or C tympanograms[9];
- For the Experimental Group: past history of occupational exposure to the noise or another chemical agent; chronical alterations in the middle ear and/or the presence of air-bone gaps in the pure tone audiometry; type B or C tympanograms[9]; time of exposure to fuels which are inferior to one year.

The groups were constituted, composed by subjects matched by gender and age:

- Control Group (CG): 23 subjects (20 male and three female; average age of 35,48 ±14,27);
- Experimental Group (EG): 21 gas station attendants (18 male and three female; average age of 40,52 ±9,38).

Auditory evaluation

With the aim of characterizing the audiological profile of gas station attendants, the auditory evaluation was composed by an initial interview, pure tone audiometry and research of acoustic reflex. Previously to the Pure Tone Audiometry (PTA), the inspection of external acoustic meatus was performed, in order to discard impediments to carry out the exams.

The speech audiometry was performed to obtain the speech reception threshold (SRT) and consequent confirmation of the tonal hearing thresholds obtained by air conduction (when the score of SRT obtained were between zero and 10 dBNS over the average of the hearing thresholds of 500, 1000 and 2000 Hz), besides the record of the speech recognition percentage index (SRPI). The tympanometry was performed to select the casuistry and obtain the acoustic reflex record in the peak of

the maximum impedance of the tympanic-ossicular system.

Interacoustics® AC40 audiometer was used, calibrated according to ISO 8253-1 standard[10], with TDH-39 supra-aural earphone, to determine the tonal thresholds by air conduction (250 to 8000 Hz), bilaterally, and, when the air thresholds were worse or the same as 25 dBHL in the evaluated frequencies, the research of hearing thresholds by air conduction (500 to 4000 Hz) was performed. It was performed with B 71 bone vibrator to discard the conductive or mixed-type hearing losses. The research technique adopted to obtain the hearing thresholds was the descending one, and the stimulus used was the *warble* type. The lowest intensity was considered the hearing threshold in which the subject perceived in 50% of the times in which was presented.

The research of the acoustic reflex thresholds was performed in the contralateral and ipsilateral measurement, in the frequencies of 500, 1000, 2000 and 4000 Hz, by Siemens® SD 30 imitanciometer. The records with absence of reflex, presence of reflex with a level of sensation equal or superior to 100 dBSL (decruitment indicative), or equal or inferior to 60 dBSL (recruitment indicative) were classified as altered. The other records were classified as normal.

Statistical analysis

The descriptive statistical analysis was performed by the determination of the average, standard deviation, minimum and maximum value of the scores obtained in the audiometry, besides the acoustic reflexes. The Chi-square test was applied to verify the association between the groups and the results of the PTA and the acoustic reflexes. The coefficient of Pearson correlation (r) was used to verify the correlation between age and the time of exposure to fuels, in the experimental group.

In all the analyses, the level of significance which was adopted was 5% (p≤0,05).

RESULTS

The average of the hearing thresholds by air conduction, of both ears, obtained in the Control and Experimental groups, respectivley, are shown in Figures 1 and 2.

The results of the speech audiometry for the SRT confirmed the PTA for both groups and ears. In the control group, the average score for the SRT was 16.7 dB (SD±6.6) for both ears. In the experimental group, this average score was 16.0 dB (SD±6.4) for the right ear and 14.1 dB (SD±5.4) for the left ear. Concerning the SRPI (monosyllables), the average score for the group control was 96.2% (SD±4.1) for the right ear and 95.3% (SD±3.1) for the left ear. In the experimental group, the average score was 94.1% (SD ±6.1) for the right ear and 95.5% (SD ±4.9) for the left ear.

The comparative analysis between the control and experimental groups did not show any difference for the average of the hearing thresholds or for the acoustic reflex thresholds. The averages for the acoustic reflex thresholds for both ears, in the contralateral and ipsilateral measurements, respectively, for the control and experimental groups, are shown in Figures 3 and 4.

The characterization of the sample related to the average age and the average time of exposure to fuels for the groups, the descriptive analysis correspondent to the results of the audiological exams classified as normal or altered and the p value, obtained by the Chi-square test, are shown in Table 1.

The analysis performed by Pearson correlation, between the variable age and time of exposure to fuels, for the experimental group, demonstrated correlation between the variables, considering tha the value (r) found was 0.78 and the value of p<0.001.

The distribution of the gas station attendants with the record of acoustic reflex considered normal or altered, in the different age ranges, is shown in Figure 5.

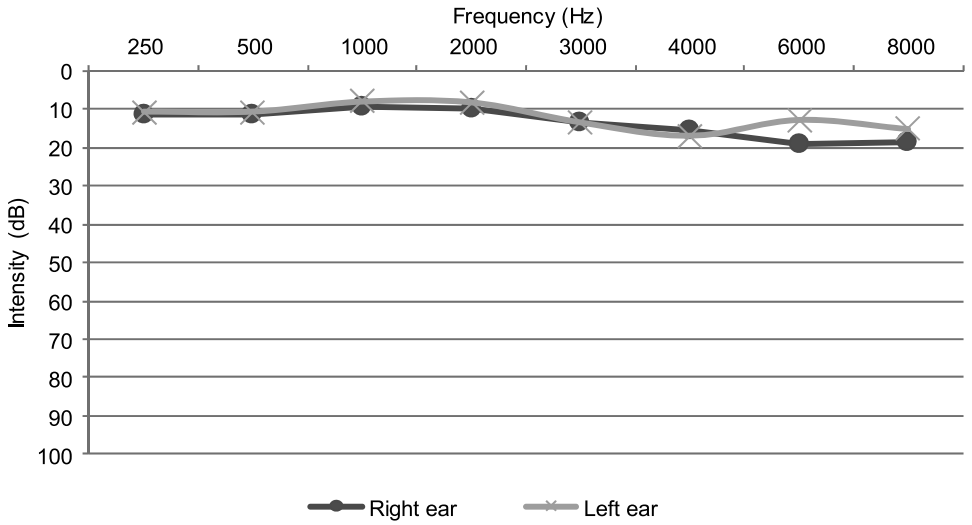

Figure 1. Mean of hearing thresholds of both ears, of the subjects of the control group

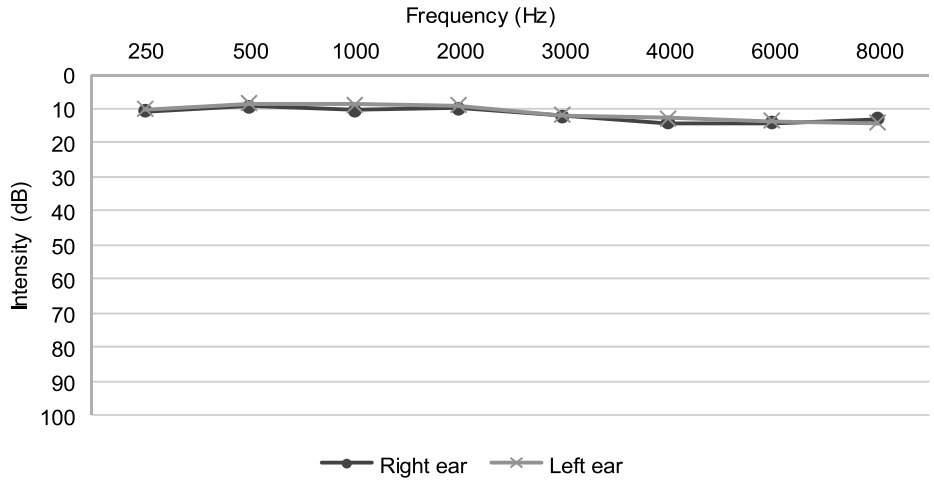

Figure 2. Mean of hearing thresholds of both ears, of the subjects of the experimental group

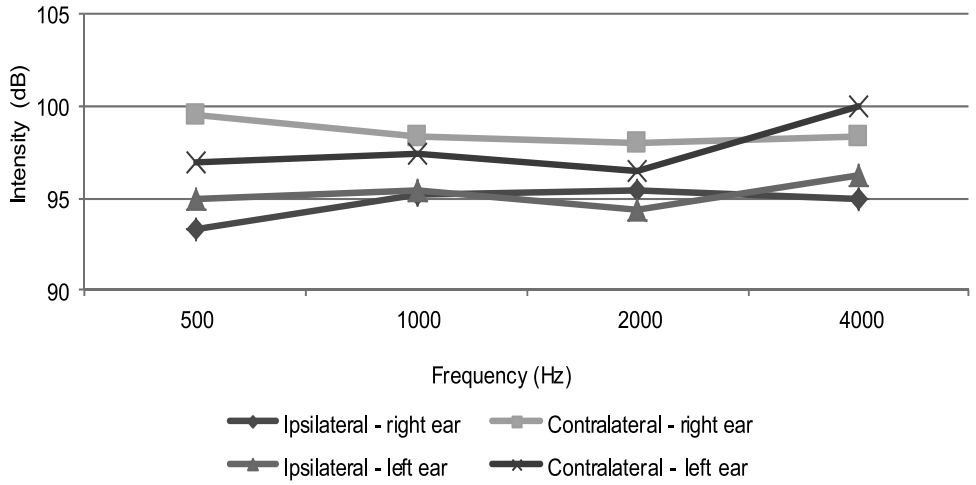

Figure 3. Mean of the acoustic reflex thresholds in both ears, in the contralateral and ipsilateral measurements, of the control group

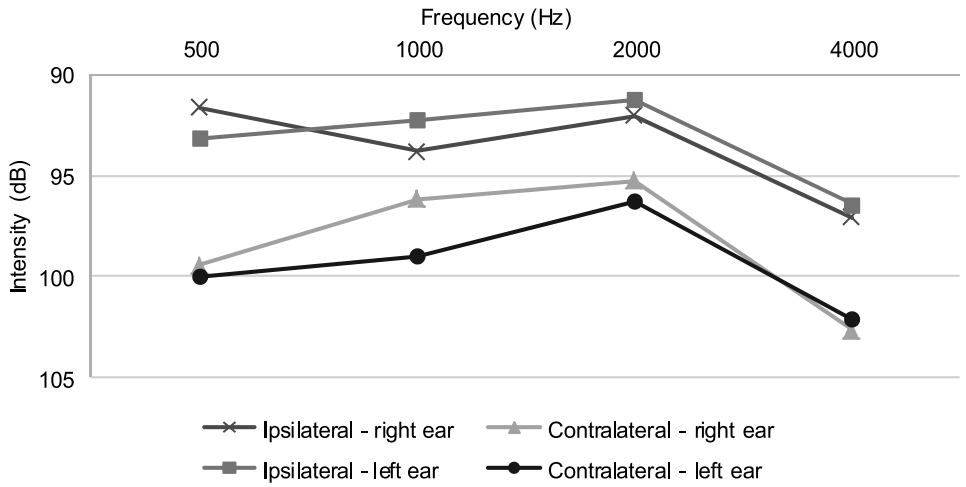

Figure 4. Mean of the acoustic reflex thresholds in both ears, in the contralateral and ipsilateral measurements, of the experimental group

DISCUSSION

The results of the current study, concerning the comparative analysis between the control and experimental groups, did not show any difference between the average of the hearing thresholds (Figures 1 and 2), differing from other researches,

Table 1. Analysis of the association between the control and experimental groups for the results of pure-tone audiometry and ipsilateral and contralateral acoustic reflexes

			Control Group (n=23)			Experimental Group (n=21)			Total (n=44)	p-value
			Age (years)		Time of exposure (years)	Age (years)		Time of exposure (years)		
		Mean (±SD)	35.48 (±14.27)		-	40.52 (±9.38)		12.2 (±7.06)	37.99 (±2.52)	0.17
Pure-tone audiometry	**RE**	Normal	14	28.6	-	16	38.9	11.3	30	0.34
		Altered	9	46.2	-	5	45.8	15.0	14	
	LE	Normal	17	29.0	-	18	39.0	11.8	35	0.46
		Altered	6	53.8	-	3	49.7	14.7	9	
Acoustic reflex	**Ipsi RE**	Normal	18	38.0	-	10	43.7	12.8	28	0.05*
		Altered	5	25.0	-	11	37.6	11.5	16	
	Contra RE	Normal	16	38.6	-	12	43.0	17.2	28	0.53
		Altered	7	28.4	-	9	37.2	12.6	16	
	Ipsi LE	Normal	17	38.9	-	13	43.5	13.0	30	0.52
		Altered	6	25.7	-	8	35.6	10.9	14	
	Contra LE	Normal	17	38.8	-	8	44.0	10.6	25	0.03*
		Altered	6	26.2	-	13	38.4	11.4	19	

*Significant values (p≤0.05) – Chi-square Test
Subtitle: RE = right ear; LE = left ear; Ipsi = Ipsilateral; Contra = Contralateral; SD = standard deviation

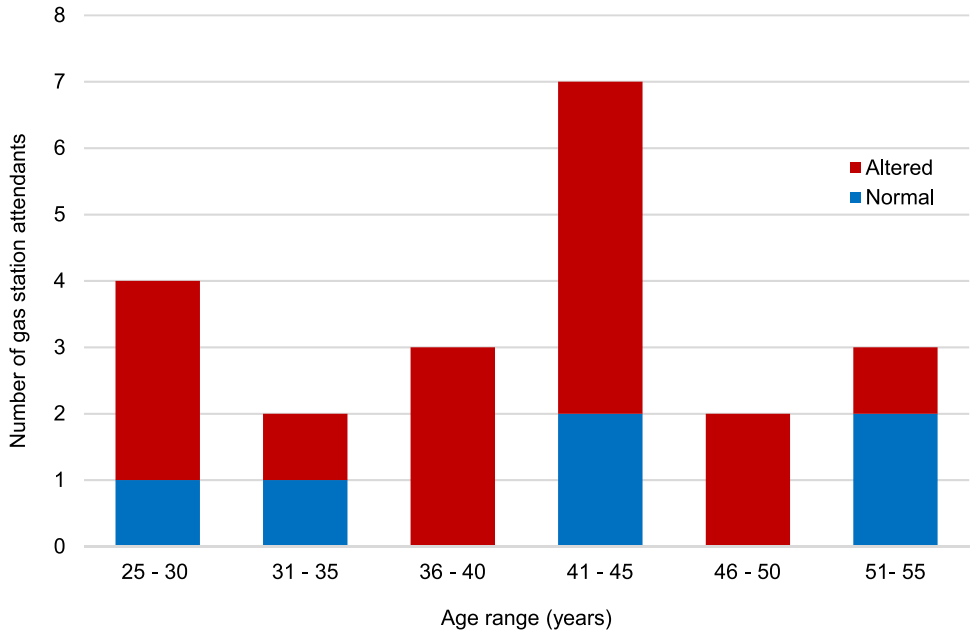

Figure 5. Representation of the number of gas station attendants with a record of normal or altered acoustic reflex, distributed by age range

which evaluated workers exposed to solvents[11] and, specifically, gas station attendants[3]. The results of these researches demonstrated difference between the control and experimental groups, for the tonal audiometry. On the other hand, in a research[12] that evaluated workers exposed to the mixture of solvents, by tonal audiometry, alterations in the hearing thresholds of the control group were also verified, as observed in the current study. Such alterations were expected, since it was necessary the pairing between the groups according to the subjects' age in order to eliminate this variable of confusion.

As for the PTA, there was no difference between the average of the acoustic reflex thresholds, both ipsilateral, and contralateral, in comparison between the groups (Figures 3 and 4). However, individually, the exam demonstrated a higher occurrence of the alterations (high or absent thresholds) in the experimental group (Table 1), with a difference for the ipsilateral acoustic reflexes for the right ear and contralateral ones for the left ear. Similar results were obtained in a research conducted with gas station attendants[3], in which a higher absence of acoustic reflexes were verified, or the presence of reflexes with

increased thresholds, in the experimental group, besides the prevalence of alterations in the contralateral reflex, compared to the ipsilateral one. Another study[13], which evaluated workers exposed to the mixture of solvents (toluene, xylene and styrene) verified in six, out of seven evaluated subjects, thresholds of abnormal ipsilateral and contralateral acoustic reflex (high or absent), in spite of normal tonal thresholds in the correspondent frequencies. In the current study, it was possible to verify that the alterations in the acoustic reflex record (Figure 5) occurred both in older subjects and in younger ones.

The alterations in the acoustic reflex verified in the experimental group (absent or increased thresholds), in the absence of conductive or facial nerve impairment, are considered unusual. Besides suggesting the involvement of the auditory nerve/low brainstem[14], they may demonstrate risk for the development of retrocochlear pathology. It is believed that the aromatic solvents may inhibit the action of the acoustic reflex in the stapedius muscle, due to its anticholinergic effects on the efferent motor neurons[15]. The toluene, solvent present in the gasoline, seems to be able to act upon the efferent auditory system, inhibiting the acoustic reflexes[16]. If the toluene, as several aromatic solvents, are able to inhibit or, more probably, disturb the efficience of the acoustic reflexes in the work environment, they could intensify the harmfulness of the exposure to the noise[15].

The joint analysis of the exams altered in the experimental group, the average time of the exposure to the fuel (Table 1), as well as the important number of alterations in the acoustic reflexes, even in young subjects (Figure 5), refer to a deleterious action, relatively precocious, of the exposure to fuels, on the auditory system. Thus, it is considered plausible to reflect on the auditory health conditions of gas station attendants, in the end of their active occupational life, developed exclusively in this function.

Considering the multiple risk agents in which gas station attendants are exposed to, and because they are toxic solvents for the hearing, it is believed this professional category must be submitted to periodic audiological evaluation, as it was evident by the results of the field researches. Also, their category must be included in hearing loss prevention programs, regardless of the solvent concentrations it is exposed to, or the simultaneous exposure to the noise[8,17]. Besides, gas station attendants remain on the sidelines of the recognition and/or prevention of solvent-induced alterations in the auditory system, once the exposure of these professionals to chemical agents is below the tolerance limits considered acceptable, theferore, not being conformed to the current rules for the services of occupational health and safety at work.

CONCLUSION

The gas station attendants showed auditory alterations, characterized by the impairment in the peripheral auditory system, suggesting toxic action of the exposure to the fuels, in the retrocochlear portion. The investigation of the central impairment, in the alterations of the acoustic reflex records, must be done by the association of audiometry and acoustic refelex research, with high sensitivity tests in the detection of alterations in the central auditory system, as the auditory evoked potentials. Considering that the gas station attendants are also exposed to the noise, the audiometry may detect the cochlear alterations caused by this exposure. However, for the identification of retrocochlear impairment (peripheral and/or central), associated or not with the alterations in the cochlea, the research on acoustic reflex is recommended, in the contralateral and ipsilateral modes. A complementary auditory evaluation must be done if alterations in the record of acoustic reflex occur, especially in the absence of a decline in hearing thresholds. Considering the evidences observed in this study, the inclusion of this professional category in hearing loss prevention programs is considered relevant.

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