



---

# Audiological assessment in police officers with and without tinnitus complaint

## Avaliação audiológica em policiais com e sem queixa de zumbido

## Evaluación audiológica en policías con y sin queja de acúfeno

*Moniane Aparecida Sumera\**

*Camila Ribas Delecrode\**

*Carla LinharesTaxini\**

*Heraldo Lorena Guida (in memorian)\**

*Vitor Engrácia Valenti\**

*Ana Claudia Vieira Cardoso\**

Paper presented at the XXIV Congress of Scientific Initiation UNESP Campus of Marília, carried out on 19 and 20 September 2012 in the city of Marília - Sao Paulo, Brazil, having been elected as the best work of the course of Speech Language Pathology and Audiology.

### **Abstract**

**Introduction:** The military service is one of the sectors in which workers are exposed to high noise levels, especially when training with firearms. Excessive exposure to this unhealthy agent is considered the most important factor for hearing loss and on set of tinnitus. **Objective:** to characterize and compare the audiological profile of police officers with and without tinnitus. **Material and Method:** this is a retrospective study comprised by 72 police officers, males, divided in two groups: group I was composed by 36 police officers who did not have tinnitus and group II by 36 police officers with tinnitus. The results were statistically analyzed. **Results:** The average age of group I was 38,81 years and average time in service of 16,22 years, and for group II, average age of 40,5 years and average time in service of 18,94 years. Group II showed a higher prevalence of hearing loss, but there was no statistically significant difference between groups. Regarding distortion product otoacoustic emissions, it was observed that the two groups

---

*\*Universidade Estadual Paulista Júlio de Mesquita Filho (UNESP-Marília), Marília, SP, Brasil.*

**Conflito de interesses:** No.

**Authors' Contribution:** MAS was responsible for the collection, tabulation, data analysis and writing of the manuscript; CRD e CLT and assisted on the study design and drafting of the manuscript; VEV worked with the statistical analysis of the study; HLG e AVC were responsible for the advising of the project, study design, discuss the findings and overall direction of the steps execution and preparation of the manuscript..

**Correspondence address:** Moniane Aparecida Sumera. Marília, SP, Brasil.

E-mail: monianesumera7@gmail.com

**Received:** 17/07/2014; **Accepted:** 20/08/2015



showed no response in the frequencies of 6.000 and 8.000 Hz. Conclusion: 52.8% of police officers with tinnitus and 33,4% of police officers without tinnitus had audiograms that suggest noise-induced hearing loss. The comparison between the groups showed that hearing thresholds average was within normal limits and absence of distortion product otoacoustic emissions at two frequencies was observed.

**Keywords:** Hearing loss; Tinnitus; Police; Occupational noise.

## Resumo

*Introdução:* O serviço militar é um dos setores onde os trabalhadores são expostos a níveis elevados de ruído, principalmente no treinamento com armas de fogo. A exposição excessiva a este agente insalubre é considerada o fator mais importante para a diminuição da audição e o aparecimento do zumbido. *Objetivo:* caracterizar e comparar o perfil audiológico de policiais militares com e sem queixa de zumbido. *Material e método:* este é um estudo retrospectivo no qual participaram 72 policiais militares, do gênero masculino, subdivididos em dois grupos: grupo I composto por 36 policiais que não apresentavam queixa de zumbido e grupo II por 36 policiais com queixa de zumbido. Os resultados foram analisados estatisticamente. *Resultados:* a média de idade dos policiais do grupo I foi de 38,81 anos e média de tempo de serviço de 16,22. Para o grupo II a média de idade foi de 40,5 anos e média de tempo de serviço de 18,94 anos. Os policiais do grupo II apresentaram uma prevalência maior de perda auditiva, porém não houve diferença estatisticamente significativa entre os grupos. Com relação às emissões otoacústicas produto de distorção observou-se que os dois grupos apresentaram ausência de resposta nas frequências de 6000 e 8000 Hz. *Conclusão:* 52,8% dos policiais com queixa de zumbido e 33,4% dos sem queixa apresentaram audiogramas sugestivos de perda auditiva induzida por ruído. A comparação entre os grupos mostrou que a média dos limiares tonais estava dentro dos padrões de normalidade e foi observada ausência de emissão otoacústica por produto de distorção em duas frequências.

**Palavras-chave:** Perda auditiva; Zumbido; Polícia; Ruído ocupacional.

## Resumen

*Introducción:* El servicio militar es uno de los sectores en que los trabajadores son expuestos a niveles elevados de ruido, principalmente en el entrenamiento con armas de fuego. La excesiva exposición a este agente insalubre es considerada como el factor más importante para la disminución de la audición y el apareamiento del acufeno. *Objetivo:* caracterizar y comparar el perfil audiológico de policías militares con y sin quejas de acufeno. *Material y método:* este estudio es retrospectivo en el que participaron 72 policías militares, del género masculino, subdivididos en 2 grupos: grupo I compuesto por 36 policías que no presentaban queja de acufeno y el grupo II compuesto por 36 policías con queja de acufeno. Los resultados fueron analizados estadísticamente. *Resultados:* El promedio de edad de los policías del grupo I fue de 38,81 años y el promedio de tiempo de servicio de 16,22 años. Para el grupo II promedio de edad fue de 40,5 años y el promedio de tiempo de servicio de 18,94 años. Los policías del grupo II presentaron una prevalencia mayor de pérdida auditiva, pero no hubo diferencia estadísticamente significativa entre los grupos. En relación a las emisiones otacústicas, producto de distorsión, se observó que los dos grupos presentaron ausencia de respuesta en las frecuencias de 6000 y 8000 Hz. *Conclusión:* 52,8% de los policías con queja de acufeno y 33,4% sin queja, presentaron audiogramas sugestivos de pérdida auditiva inducida por ruido. La comparación entre los grupos demostró que la media de los umbrales tonales estaba dentro de los patrones de normalidad y se observó ausencia de emisión otacústica como producto de distorsión en dos frecuencias.

**Palabras clave:** Pérdida auditiva; Acufeno; Policía; Ruido en el ambiente de trabajo..



## Introduction

Scientific studies have shown that the firearm can cause noise-induced hearing loss due to damage caused in the cochlea cells<sup>(1,2)</sup>. The consequences of exposure to impact noise depend of individual susceptibility, number of shots or explosions, distance between the ear and the fire gun and use of protectors<sup>(3)</sup>. Noise induced hearing loss (NIHL) represents a serious damage that interfere in security, quality of life and services of police officers<sup>(4)</sup>.

NIHL is characterized by a change in hearing thresholds, sensorineural loss, symmetrical, irreversible and progressive. Initially it affects the frequency range between 3000 Hz and 6000, threshold in 8000 Hz has to be better than the worst threshold (3000, 4000 or 6000 Hz)<sup>(5)</sup>.

International surveys of military police showed different rates of hearing loss prevalence ranging from 18 to 30%<sup>(6-8)</sup>. In Brazil, the prevalence of hearing loss in military police ranged from 25 to 38.1%<sup>(9-11)</sup>.

One of the symptoms that have been associated with noise-induced hearing loss is tinnitus, which can be defined as an auditory illusion, i.e. a sound sense not related to an external source of stimulation<sup>(12)</sup>.

In literature, it was found a study that pointed tinnitus as one of the main hearing complaints (n = 52/26%) in police officers<sup>(11)</sup>.

Brazilian authors observed that after shooting practice, militaries reported the following symptoms and complaints: tinnitus (23%), temporary hearing loss (7,6%), headache (3%) and irritation (3%)<sup>(9)</sup>.

The literature recommends that workers occupationally exposed to noise should have their hearing monitored annually. The most common procedure is the pure tone audiometry as a way to estimate the effects of noise on hearing function<sup>(13)</sup>.

In Brazil, there exists specific legislation that establishes guidelines and minimum standards for workers' hearing evaluation and monitoring. It provides subsidies for the establishment of programs that aim the prevention of noise induced hearing loss and the preservation of workers' hearing health. This ordinance recommends that audiometric assessment should be performed, at least, at the time of admission, in the sixth month, annually thereafter, and in dismissal<sup>(14)</sup>.

It is known that assessment using pure tone audiometry as a single test is not suitable for the description and detection of changes in the auditory system<sup>(15)</sup>. Thus, literature has recommended the use of otoacoustic emissions for early detection and monitoring of cochlear dysfunction due to exposure to military noise<sup>(16)</sup>.

Considering the above, the aim of this study was to characterize and compare the audiological profile of military police with and without tinnitus.

## Material and method

This is a retrospective, documental and comparative study. The data were collected at the Audiology records of Centro de Estudos de Educação e Saúde (CEES), Faculdade de Filosofia e Ciências, Universidade Estadual de São Paulo (UNESP), Marília, São Paulo. The criteria adopted for selection were as follow: the participant should work as military police, have performed audiological assessment in the period of 2008-2010 and the presence or absence of tinnitus complaint.

The database consisted of 300 military policemen, after analysis of the records 92 that met the criteria were selected. Of these, 20 were excluded due to changes in tympanometry, because middle ear involvement could prevent or compromise otoacoustic emissions achievement<sup>17</sup>.

Then, the sample was composed of 72 military police officers, male, who were divided into two groups according to presence or absence of tinnitus complaint. Group I consisted of 36 officers without tinnitus complaint and group II by 36 officers with tinnitus complaint.

It is relevant to mention that the officers' qualification includes annual shooting training, regardless of operating area. The trainings are conducted in groups of twelve to fifteen police officers and only the police who are shooting use the hearing protection. Each police shoots at least 50 times, so, at the end of each training each military has been exposed to more than 600 noise impacts. Currently, the weapon used is a .40 pistol, Taurus brand, with ammo from the Companhia Brasileira de Cartuchos.

In the audiological anamnesis there was not researched information regarding non-occupational exposure.



The audiological assessment was conducted at the Audiology Sector of Centro de Estudos de Educação e Saúde (CEES), UNESP-Marília. The pure tone audiometry was performed after 14 hours of auditory rest. All assessment was conducted in a soundproof booth, for pure tone audiometry it was used the GSI 61 GrasonStadler with TDH-50 phone, calibrated according to norms ANSI-3.6 / ISO 389(18). The acoustic immittance assessment was performed with a GSI 38 GrasonStadler, calibrated according to norms ANSI S3.6 / ISO 389 and finally, distortion product otoacoustic emissions (DPOAE) were researched using the Biologic Navigator Pro device with Scout software.

Air conduction was tested in the frequencies 250-8000 Hz and, when required, bone conduction was investigated. In this population, pure tone audiometry was classified according to ordinance 19, of Ministry of Labor. In this ordinance normal audiometric thresholds are those that are less than or equal to 25 dB (HL) in all frequencies and suggestive of noise induced hearing loss audiometric thresholds above 25 dB (HL) and/or higher in the frequencies of 3000 and/or 4000 and/or 6000 Hz (14). The tympanometry was classified according to Jerger, (1970)<sup>19</sup>.

Distortion product otoacoustic emissions (DPOAE) were obtained by the simultaneous presentation of two pure tones  $f_1$  and  $f_2$ . These pure tones, called primary frequency, are expressed by the ratio of 1.22. In this study was analyzed the response equivalent to  $2f_1-f_2$  and the intensity ratio of  $L_1=65$  and  $L_2=55$  dB SPL ( $^{\circ}0$ ). The frequencies analyzed were 1000, 2000, 3000, 4000, 6000 and 8000 Hz and the otoacoustic emissions were

present when the signal / noise ratio was greater than or equal to 6 dB.

The Shapiro-Wilk test was applied to analyze the normality of the distributions. To compare the two groups (GI and GII) it was used the Mann Whitney test. It was also applied the chi-square test to assess the association between tinnitus and hearing loss in the military police. It was considered significant differences  $p < 0.05$  and the confidence interval was built with 95% statistical confidence.

This study was reviewed and approved by the Ethics Committee of the Faculdade de Filosofia e Ciências UNESP, Marília-SP (Protocol No. 476159 / 2010-5).

## Results

Group I, without tinnitus complaint, was composed of police officers aged from 30-48 years (mean of 38.8 and standard deviation of 4.79) and group II, with tinnitus complaint, by police officers aged from 21-49 years (mean of 40.5 and standard deviation 5.80).

Regarding the time of service, the police officers of group I perform this function for 2-29 years (mean 19.22 and standard deviation of 6.55) and group II, 2-25 years (mean 18.94 and standard deviation of 5.54).

Pure tone audiometry findings showed that group II had a higher prevalence of hearing loss when compared to group I, but this difference was not statistically significant (Table 1).

**TABELA 1.** PREVALÊNCIA DE PERDA AUDITIVA EM POLICIAIS DOS GRUPOS GI E GII

AUDIOMETRIA TONAL	GI		GII		TOTAL	
	N	%	N	%	N	%
<b>AUDIOMETRIA NORMAL</b>	24	66,6	17	47,2	41	57
<b>SUGESTIVO DE PAIR UNILATERAL</b>	6	16,7	9	25	15	20,8
<b>SUGESTIVO DE PAIR BILATERAL</b>	6	16,7	10	27,8	16	22,2
<b>TOTAL</b>	36	100	36	100	72	100

Legend:

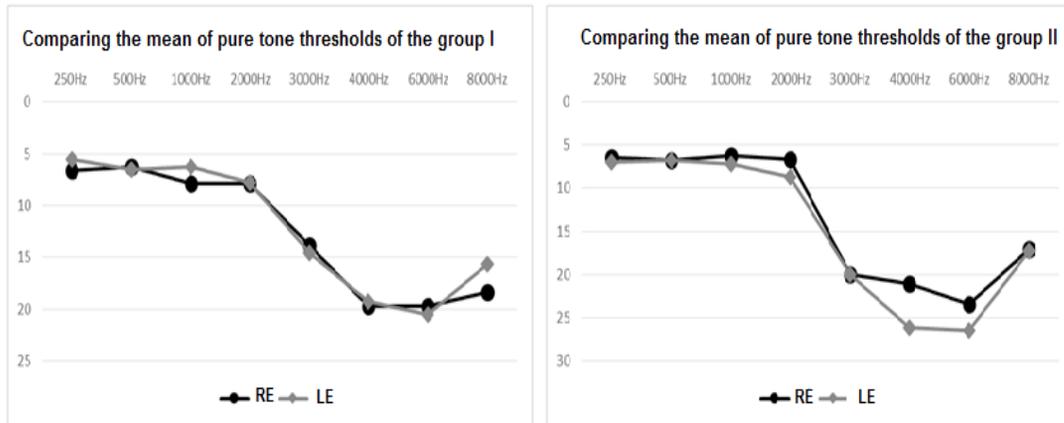
NIHL= noise induced hearing loss

GI - group without tinnitus / GII - group with tinnitus

p = significance at  $p < 0.05$  \*

Analysis of pure tone thresholds average showed that police officers of group I (Figure 1) presented thresholds within normal limits bilaterally, but it can be seen a worsening in the frequencies between 3000 and 8000 Hz on both ears. In group II, the average thresholds were within normal

limits, but there was a worsening in the frequencies between 3000 Hz and 8000 Hz, bilaterally. In 4000 and 6000 Hz, on the left ear, it was noted that the average of thresholds were above 25 dB (NA) (Figure 1)..



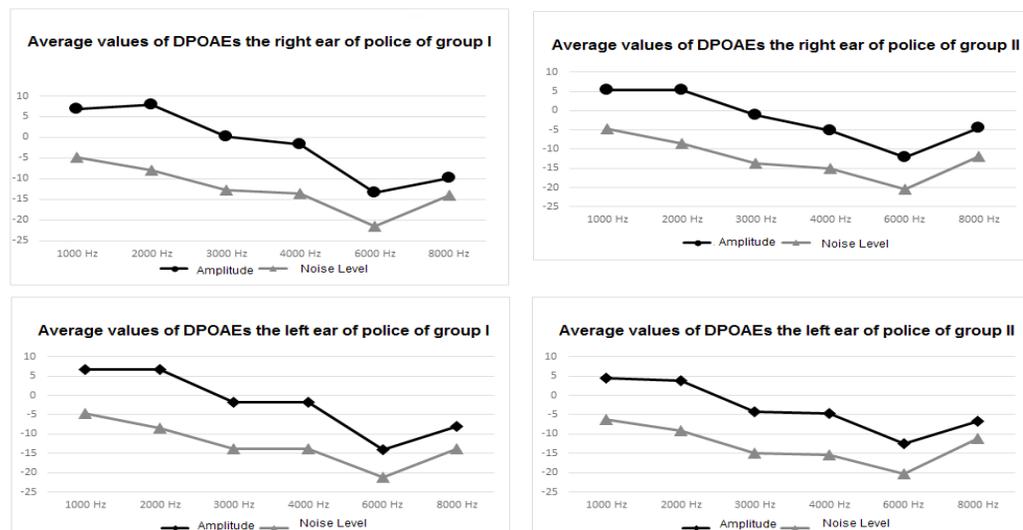
**FIGURE 1-** MEAN VALUES OF PURE TONE AUDIOMETRY, OF GROUPS I AND II, ACCORDING TO THE FREQUENCY, IN BOTH EARS

Legend: RE - Right ear / LE - Left ear.

GI - group without tinnitus / GII - group with tinnitus

The results of distortion product otoacoustic emissions demonstrated absence of response in the frequencies of 6000 and 8000 Hz in both ears of

group I and, in the left ear of Group II. It was also noted that police officers in Group II showed no response to the frequency of 6000 Hz in the right ear (Figure 2)..



**FIGURE 2 -**MEAN VALUES OF DPOAES OF GROUPS I AND II, RIGHT AND LEFT EAR.

Legend: DPOAEs – Distortion product Otoacoustic emissions

GI - group without tinnitus / GII - group with tinnitus

Table 2 presents a comparison of amplitude and signal/noise ratio of distortion product otoacoustic emissions in both groups. Statistical analysis showed a statistically significant difference between

groups I and II to amplitude and signal / noise ratio in the frequency of 8000 Hz in the right ear..

**TABLE 2.** COMPARISON OF DPOAE AMPLITUDE AND NOISE-SIGNAL RATIO OF GROUPS I AND II, DISTRIBUTED ACCORDING TO FREQUENCY AND EAR

Frequency (Hz)	AMPLITUDE P		SIGNAL-NOISE RATIO P	
	GI -GII	GI - GII	GI - GII	GI - GII
	OD	OE	OD	OE
1000	0,84	0,11	0,15	0,75
2000	0,14	0,66	0,15	0,06
3000	0,65	0,38	0,85	0,70
4000	0,47	0,38	0,30	0,82
6000	0,76	0,51	0,93	0,68

Legend: RE - right ear / LE - left ear

GI - group without tinnitus / GII - group with tinnitus

Analysis using the Mann Whitney test, significant values are bold and with an asterisk.

p = significance at p <0.05 \*

## Discussion

The literature reports that there is a close relationship between tinnitus complaint and the presence of hearing loss. A study found that approximately 85% of individuals with tinnitus complaint had some degree of hearing loss<sup>(21)</sup>.

Another study showed that eight to 10% of individuals with tinnitus complaint had normal audiometry<sup>(22)</sup>.

Research of workers exposed to noise and organophosphate related tinnitus with hearing loss in individuals with and without tinnitus complaint. The results showed that workers with tinnitus complaint had a higher prevalence of abnormal audiometry (60.87%)<sup>(23)</sup>.

The results of this study showed that police officers of the group II, with tinnitus, had a prevalence of 52.8% of audiograms that suggest noise-induced hearing loss. This result is close to that observed in another study<sup>(23)</sup>.

Pure tone audiometry is the most widely method used for the diagnosis of NIHL. However, in the literature, there are reports that initial lesions to the auditory system are not detected by pure tone audiometry; it is diagnosed only when the damage is already irreversible<sup>(24)</sup>.

Then, it is also necessary to perform distortion product otoacoustic emissions that allows an objective and more reliable evaluation of cochlear conditions<sup>(25-27)</sup>, since they assess the integrity of the outer hair cells of the organ of Corti<sup>(28)</sup>.

In this study, it was observed absence of distortion product otoacoustic emissions, on both groups, at 6000 Hz and 8000, although the average of pure tone thresholds at these frequencies are within normal limits. This absence of otoacoustic emissions might be because the two groups were exposed to noise impact and the sensitivity of this test is in detecting small changes in cochlear function. The reduction in the level of otoacoustic emissions may be an early indication of a hearing loss in military<sup>(3)</sup>.

A diffuse lesion, up to 30% in the outer cochlear hair cells (OHC), would not have significant impact on audiometric thresholds; it would be an injury without representation in conventional audiometry<sup>(29)</sup>.

Moreover, the effects of noise in the auditory system are not limited only to cochlear injury; noise exposure increases the concentration of cytoplasmic calcium in OHCs, increases the release of glutamate (excitatory neurotransmitter of the auditory pathway) and increases neural activity of afferent fibers, which can lead to tinnitus<sup>(30)</sup>.

Study of military with and without exposure to impact noise showed significant difference between groups, both for audiometric thresholds and the amplitude of distortion product otoacoustic emissions in frequencies of 3000 Hz in the right ear and 4000 and 8000 Hz in the left ear <sup>(9)</sup>.

The results of this study showed significant differences both in the amplitude and in signal to noise ratio only to the frequency of 8000 Hz in the right ear. In the compiled literature, there are no studies that made this comparison.

The use of distortion product otoacoustic emissions can be a complementary tool in the audiological evaluation of police officers, once in this study the police showed absence of response at high frequencies with audiometric thresholds within normal limits.

## Conclusion

In this study, it was observed that 52.8% of the military police with tinnitus complaint, and 33.4% of those without complaint, had audiograms that suggest noise-induced hearing loss. The comparison between pure tone thresholds average of the two groups showed that they were within the normal range bilaterally and, that in both groups distortion product otoacoustic emissions were absent in the frequencies of 6000 and 8000 Hz.

## References

1. Updike C, Kramer W. Hearing loss in recreational shooters. *The Hearing Journal* 1990; 43(1): 22-4.
2. Chung DY, Gannon RP, Willson GN, Mason K. Shooting, sensorineural hearing loss and workers' compensation. *J Occup Med*. 1981; 23:481-4.
3. Konopka W, Zalewski P, Pietkiewicz P. Evaluation of transient and distortion product otoacoustic emissions before and after shooting practice. *Noise Health*. 2001; 3(10):29-37.
4. Yankaskas K. Prelude: Noise-induced tinnitus and hearing loss in the military. *Hear Res*. 2013; 295: 3-8.
5. Comitê Nacional de Ruído e Conservação Auditiva (BR). Perda auditiva induzida pelo ruído relacionado ao trabalho. *Acta AWHO*. 1994; 13(3): 126-7.
6. Walden BE, Prosek RA, Worthington DW. The prevalence of hearing loss within selected U.S. Army branches. *Walter Reed Army Medical Center, Washington*; 1975.
7. Ohlin D. Epidemiologic report: hearing evaluation audiometric reporting system (HEARS). *Medical Surveillance Monthly Report*. 1996; 2: 8-9.
8. U.S. Army Center for Health Promotion and Preventive Medicine. DOEHS Data Repository: hearing conservation program positive STS report, 1983-2003. Data provided to the IOM Committee on Noise-Induced Hearing Loss and Tinnitus Associated with Military Service from World War II to the Present, Washington, 2004.
9. Heupa AB, Gonçalves CGO, Coifman H. Efeitos do ruído de impacto na audição de militares. *Braz. J. Otorrinolaringol. 2011; 77(6): 747-53.*
10. Silva AP, Costa EA, Saete MMR, Souza HLR, Massafera VG. Audiometric assessment for military personnel. *Rev Bras Otorrinolaringol*. 2004; 70: 344-50.
11. Guida HL, Diniz TH, Chagas PSC, Kinoshita SK. Perfil audiológico em policiais militares do estado de São Paulo. *ArqIntOtorrinolaringol*. 2010; 14(4): 426-32.
12. Zumbido. Disponível em: [http://www.forl.org.br/pdf/seminarios/seminario\\_45.pdf](http://www.forl.org.br/pdf/seminarios/seminario_45.pdf). Acesso em 21 de novembro de 2014.
13. Mello AP, Waismann W. Occupational Exposure to Noise and Industrial Chemicals and Their Effects on the Auditory System: Revision of Literature [periódico online]. @rqinto-*torrinolaringol*;
14. Disponível em: URL :[http://www.arquivosdeorl.org.br/conteudo/acervo\\_port.asp?id=285](http://www.arquivosdeorl.org.br/conteudo/acervo_port.asp?id=285). Acesso em 12 de março de 2014.
15. Ministério do Trabalho (BR). Portaria n. 19 GM/SSSTb, de 9 de abril de 1998. Estabelece diretrizes e parâmetros mínimos para avaliação e acompanhamento da audição em trabalhadores expostos a níveis de pressão sonora elevados. *Diário Oficial da República Federativa do Brasil*. 1998 Abr 22.
16. Morata TC, Little MB. Suggested guidelines for studying the combined effects of occupational exposure to noise and chemicals on hearing. *Noise Health*. 2002; 4 (14): 73-87.
17. Dhar S, Hall III JW. Otoacoustic Emissions: Principles, Procedures, and Protocols. San Diego: Plural Publishing; 2012.
18. Keefe DH. Spectral shapes of forward and reverse transfer functions between ear canal and cochlea estimated using DPO-AE input/output functions. *J Acoust Soc Am*. 2002; 111:249-60.
19. Momensohn-Santos TM, Russo ICP, organizadores. *Prática da audiologia clínica*. 7a. ed. São Paulo: Cortez; 2009.
20. Jeger S, Jeger J. Alterações auditivas: um manual para avaliação clínica. São Paulo: Atheneu; 1996.
21. Burguetti FAA, Peloggia AG, Carvalho RM. Amplitude de emissões acústicas produto de distorção em indivíduos com queixa de zumbido. *Braz J Otorhinolaryngol*. 2002 Nov/Dez; 68(6): 883-90.
22. McFadden, D. Tinnitus: facts, theories and treatments. Washington (DC): National Academy Press; 1982.
23. Barnea G, Attias J, Gold S, Shahar A. Tinnitus with normal hearing sensitivity: extended high-frequency audiometry and auditory nerve brain-stem-evoked responses. *Audiology*. 1990; 29(1): 36-45.
24. Delecrode CR, Freitas TD, Frizzo ACF, Cardoso ACV. Prevalence of tinnitus in workers exposed to noise and organophosphates. *Int Arch Otorhinolaryngol*. 2012; 16(3): 328-34.
25. Glorig A. Noise: past, present and future. *Ear Hear*. 1980; 1: 4-18.
26. Marshall L, Miller JAL, Heller LM, Wolgemuth KS, Hughes LM, Smith SD, Kopke RD. Detecting incipient inner-ear damage from impulse noise with otoacoustic emissions. *J Acoust Soc Am*. 2009; 125(2):995-1013.
27. Guida HL, Morini RG, Cardoso ACV. Avaliação audiológica e de emissões otoacústicas em indivíduos expostos a ruído e praguicidas. *ArqIntOtorrinolaringol*. 2009; 13(3): 264-9.



27. Atcharyasathian V, Chayarpham S, Saekhow S. Evaluation of noise-induced hearing loss with audiometer and distortion product otoacoustic emissions. *J MedAssocThai*. 2008; 91(7):1066-71.

