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Audiological analysis in military police officers with exposure to occupational noise in motorized patrol activity

K. C. S. de Lima[a], L. B. da Silva[b], V. S. B. Gonçalves[c], E. L. de Souza[d], J. G. B. Fernandes[e]

[a]Department of Production Engineering, Federal University of Paraiba, BR (lima.kelly3@gmail.com) ORCID: 0000-0001-7611-7373. [b]Department of Production Engineering, Federal University of Paraiba, BR (bueno@ct.ufpb.br) ORCID: 0000-0003-4624-2075. [C]Department of Production Engineering, Federal University of Paraiba, BR (valeriagoncalves291@gmail.com) ORCID: 0000-0002-7285-000X. [d]Department of Production Engineering, Federal University of Paraiba, BR (elopesouza@gmail.com) ORCID: 0000-0002-7098-9438. [e]Department of Production Engineering, Federal University of Paraiba, BR (ze_fernandes1@hotmail.com) ORCID: 0000-0001-6803-9153.

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Abstract

The aim of this article is to present the results of audiological findings from a selection of military police officers with exposure to occupational noise, in the motorized patrol activity, in João Pessoa city. The data collected from the motorcycle police sample were compared with the ISO 1999: 2013 Standard. The research was performed in 46 police officers, whose mean age was 32.7 years old and a mean service time of 10.5 years. For the subjects' selection and inclusion in the study, interviews were conducted, in addition to questionnaires, ontological examination, audiometric tests and the respective noise level measurements performed by a personal dosimeter, according to ISO 9612:2009 Standard recommendations. Findings from questionnaires showed that 51% of the police officers reported to have some type of hearing complaints; through audiometric tests, 36.1% of the cases suggested hearing loss. The most significant hearing threshold change occur in the range from 3000Hz and 4000Hz. Hearing thresholds shifts suggest the occurrence of some Noise Induced Hearing Loss (NIHL) level in motorcycle police officers who are over 30 years and 10 years of service. Besides, compared with the data from ISO 1999:2013 standard, there is a decrease in the auditory level of these professionals after three years on service, and a noise exposure of Lex, 8h = 96.9 dB(A).

1. INTRODUCTION

Generally, natural aging processes decrease the hearing capacity of human beings in a gradual manner and without the occurrence of very noticeable symptoms. This process occurs with the loss of vitality of hair cells located in the organ of Corti, in the inner ear - responsible for decoding the sounds - which lose their effectiveness and die, impairing hearing permanently (Mendes, 2013; Melo Junior, 2011). Exposure to noise, depending on its duration, intensity and frequency, adds a greater load to hair cells, causing their death by asphyxiation and loss of hearing in a permanent way. Regardless of age, this exposure is harmful and may reduce the hearing capacity, from 20Hz to 20,000Hz of frequency (Nassiri et al., 2013).

The effects that noise can cause in human organism vary from extra-hearing effects (dizziness, insomnia, irritation, gastrointestinal and cardiorespiratory problems) to hearing effects (tinnitus, earaches, itching, hearing loss capacity), either permanently or temporarily. The NIHL is irreversible, progressive according to the exposure time and, the most devastating consequences of noise, since this disease leads to work and social incapacity (Yankaskas, Metidieri et al. 2013; Mrena et al., 2009; Maia, 2008).

Cited by many authors as the most harmful effect of noise exposure, hearing loss may occur in any individual who has a certain contact with the risk agent, at levels above the permitted and without the use of appropriate protection.

The traditional way to diagnose this loss is through audiometric tests and the application of specific questionnaires to identify health and working conditions that are related to hearing (Melo Junior, 2011). Marini, Halpern & Aerts (2005) argue that the use of questionnaires whose investigate the perception of hearing complaints is from a great importance in the detection of noise effects in the body and in the diagnosis of hearing loss.

Exposure to noise, present in various work activities, represents a risk factor for performance, safety and health of workers, which must be controlled or eliminated from the working environment (Maia, 2008). The military policing activity characteristics lead to situations in which exposure to noise is unavoidable, impairing the health and quality of life of these professionals. The noises coming from the radio communicator, urban traffic, vehicles used in patrol, environmental noises and the siren, can add a greater risk to the auditory capacity of these professionals (Guida et al., 2010). These environmental conditions in various patrol sites bring harm to the health of the military police officers, and the sound of gunshots, risk source most studied in the literature, amplifies the magnitude of the consequences of their exposure, especially by hearing loss or acoustic trauma generated after contact with such a noise (Lima & Silva, 2014).

However, some authors limit their study to hearing conditions of the military, regardless of the sources of exposure to the noise present in their activities. Silva et al. (2004) present the audiological profile in a Brazilian military barracks; Santos, Juchem & Rossi (2008) discuss the results of auditory processing in military staff with exposures above the limits of daily tolerance; and Lesage et al. (2009) study the NIHL of patrolling activities in French police. Heupa, Gonçalves & Coifman (2011) analyze the impact of noise firearms' shots on Brazilian military staff, and Guida, Diniz & Kinoshita (2011) present the results of acoustic and psychoacoustic analysis of noise produced by gunmen in Brazilian military police. Other studies have also investigated the conditions of military police officers related to auditory safety, such as Barney et al. (2006), Bohnker et al. (2002), Henselman, Henderson, Shadoan, Subramaniam, Saunders & Ohlin (1995), Colle, Legrand, Govaerts, Veken, De Boodt & Degrave (2011).

The intention to improve the diagnosis of hearing loss in military police officers, Guida, Sousa & Cardoso (2012) and Gilbertsonm & Vosburgh (2015) present the results of the relationship among audiometry findings and otoacoustic emissions that have demonstrated effectiveness in detecting hearing loss induced by noise frames. Finally, Lima et al. (2015) discuss the risk of hearing loss development in military police officers, due to the characteristics of their exposure and daily noise levels that exceed regulatory limits. Given this context, this article aims to present the results obtained through audiological findings of a selected group of military motorcycle-patrol police officers who are exposed to occupational noise in the city of João Pessoa.

2. METHODS

This study was approved by the Ethics Committee of the Federal University of Paraíba under the Protocol number 0217/2014. This way, all participants of the military police voluntarily signed the free and informed consent form. The selection of 46 motorcycle police officers was conducted upon an initial identification of the noise sources in the activity, application of a questionnaire of occupational anamnesis and initial hearing tests in accordance to recommendations presented in ISO 9612 (2009) standards, ISO 1999 (2013) and Brazilian standards NR-15 (2011) and NHO-01 (2001).

Data collection was performed in three steps:

(1) Selection of police officers through the application of an occupational questionnaire and initial hearing tests;

(2) Measurement of noise levels in the activity of motorcycle police officers; and

(3) Perform of audiometric tests by a qualified professional in the field of speech therapy, as required by the Brazilian legislation.

The criteria of inclusion and exclusion in the research were: being male, to ensure uniformity in the results of audiometric tests; having more than three years of service as a motor patrol officer, considering that after this time it is possible to detect the effects of exposure to noise; not having history of, or hearing problems.

Primarily, the occupational questionnaire applied to the military police officers aiming to investigate the main health complaints that may be related to the extra-auditory effects due to noise exposure and also the symptoms of hearing complaints, both declared in a subjective and personal way.

This questionnaire is composed by questions about military policing activity, work hours, overtime hours, age, service time, and work tasks. Besides this information, the cited tool is also composed of questions about hearing health, occurrence of auditory (tingling, itchy inner ear, pain, difficulties of speech recognition) and extra-auditory symptoms (insomnia, irritability, dizziness, headache) and previous history cases of hearing problems in the family or in the individual itself as hypertension, smoking, mumps, meningitis and other significant events that can modify the functioning of the inner ear, in accordance with Mendes (2013).

After applying the occupational questionnaire, physical exams with the inspection of acoustic meatus and the hearing channel were performed in order to appoint eventual problems that would make impossible the execution of audiometric tests; thus, this exam is eliminatory. In applying the tonal audiometric tests, frequencies of 250Hz, 500Hz, 1000Hz, 2000Hz, 3000Hz, 4000Hz, 6000Hz and 8000Hz were tested, through bone conduction and by air. Bone conduction frequency test was promoted to determine the location (internal and external ear) of the hearing damage in suggestive cases of hearing loss; in order to classify these losses in NIHL or mixed hearing loss. The gap utilized to determine the type of hearing loss was 15 dB, according to the recommendations of the Brazilian National Council of Speech.

The equipment used to apply the tests was the AVS 500 audiometer, calibrated according to ISO 8253-1 (2010) and installed in a soundproof room. A professional qualified in phonoaudiology, with regular registration in the Brazilian Phonoaudiology Council, conducted the audiometric tests. Measurement of noise levels of military policing activity was performed after the application of audiological tests. The equipment used was a noise dosimeter Quest Q-400, calibrated with the Quest QC-10 calibrator. In the overall evaluation, the noise levels of each source inherent to the activity were not identified, but the total noise value that reached the auditory region of the military police officers. Therefore, a microphone was fixed at the shoulder height, at a 15 cm distance from the hearing canal entrance. Sources of noise exposure in the military police activity are recognized as the sounds of sirens and the motorcycles, the noise of urban traffic, environment, radio communicator and shots of firearms in the patrol activity. During firearms training, police officers use hearing protection; use of firearms is not very widespread in the police operations in the city of Joao Pessoa, given the low level of local crime.

Therefore, the total duration of the measurement was eight hours, which respects the journey of Brazilian nominal work and the limitations of the equipment used. The values of the equivalent level of noise (LAeq, T) were extended for eight hours (Lex, 8h), and noise levels (NHO-01, 2001) were designed for different motorcycle police officers work schedules: 8, 12 and 24 hours. For data analysis, measures of central tendency were used, t-Student hypothesis test (with $\alpha = 0.05$), Mann Whitney test (with $\alpha = 0.05$), Fischer test (with $\alpha = 0.05$) and Pearson correlation analysis. Furthermore, comparisons were made among audiological findings of the sample with the database of ISO 1999: 2013 of an ontologically normal population. Excel, R and AutoCAD (for the preparation of the charts) software were used for data analysis.

3. RESULTS AND DISCUSSION

Initially, 46 motorcycle police officers were selected from the available volunteers. Monitored activities were carried out in urban patrolling actions during daytime and nighttime. The organization of the Brazilian police is military in nature. In this context, police officers with the patents of soldier, corporal, lieutenant, sergeant and captain participate in the study. After the initial questionnaires and an initial auditory examination (otoscopy), the sample was reduced to 36 policemen. The excluded volunteers did not meet the defined criteria for inclusion because they had some disease or injury that could introduce bias in the study. It was also found that the included volunteers had no history of hearing disorders and did not undergo audiometric testing prior to screening.

The selected group has an average age of 32.7 years old, with 10.5 years as military police officer. More than 50% of these subjects work an average of 8.5 hours a day, with one-hour meal intervals. About 36.2% carry out extra work within the organization after normal working hours, and 31.9% of them have other work activities outside the organization.

According to ISO 1999 (2013), for comparing the values obtained by the audiometry with the standard database, a distribution of population data in specific age groups was made: (1) group aged 20-29 years (30.5%) and average service time of 5.5 years; (2) group aged 30-39 years (56.4%) with an average service time of 11 years and, (3) group aged 40-49 years (13.1%) with an average service time of 21.7 years.

3.1. Occupational questionnaire

The application of the occupational questionnaire (Table 1) showed that most police officers could clearly identify some symptoms of hearing complaint. Moreover, they realize that their work conditions increase that perception. Auditory and extra-auditory symptoms, resulting from exposure to noise, were identified. Only 19.2% has reported no hearing complaints, which means that their working conditions and noise exposure do not harm their hearing, according to their own perception. Through results obtained and the application of Fisher test (with α = 0.05) identified a dependency among the occurrence of hearing complaint report with the statement of auditory symptoms (p-value = 9.123e-07 <0.05), and an independence of hearing complaints regarding the statement of extra-auditory symptoms (p-value = 1> 0.05). These preliminarily findings indicate the presence of hearing complaints especially when there are reports of auditory symptoms in this population sample.

Regarding hearing complaints statements, there was a higher number of cases belonging to an age group of 30-35 years with 5-12 years of service time. In data analyzed, the variation among the categories "reported hearing complaints" and "did not report any hearing complaints" is most evident when it comes to service time than only age itself. This tendency may represent a greater influence of this variable in the results.

Table 1. Anamnesis questionnaire results

Identify	n	%
Hearing complaints	18	51
Auditory symptoms	9	25.5
Extra-auditory symptoms	2	4.3
No hearing complaints	7	19.2
Symptoms	n	%
Constant or periodic headache	22	46.8
Insomnia	17	36.2
Itching inner ear	17	36.2
Tinnitus	14	29.8
Hypertension	3	6.4
Measles	2	4.3
Mumps	3	6.4

Table 1 also shows that regarding the reported symptoms, constant or periodic headache is the most frequent symptom, followed by insomnia and itchy inner ear. Tinnitus in one or both ears was declared by 29.8% of the analyzed military police officers. In addition to these identified symptoms, the police officers also claimed to have, in more isolated cases, hypertension, measles and mumps; these pathologies may contribute to the susceptibility of occurrence of hearing loss (Melo Junior, 2011). Similar results were found in other studies with military police officers (Silva et al., 2004; Mariani, Halpern & Aerts, 2005; Guida et al., 2010; Guida, Diniz & Kinoshita, 2011; Guida, Souza & Cardoso, 2012) in which the prevalence of headache cases and tinnitus are identified as initial symptoms of overexposure to noise. Melo Junior (2011) and Metidieri et al. (2013) have pointed out that individual perception of noise effects decreases due to the occurrence of hearing loss; and they reinforce that the presence of tinnitus is one of the early symptoms of NIHL.

3.2. Noise exposure

The results of activity noise levels measurement indicate a value of Lex, 8h = 96.9 dB (A) in a period of eight hours with a dose of 408%. The values of the dose designed for 12 and 24 hours are, respectively, 612% and 5103%. This amount is above the tolerance limit for the Brazilian standards - NR 15 (2011) and NHO-01 (2001) -, that is 85 dB (A) for a similar duration with a dose of 100%.

In addition to the Brazilian regulations, this noise exposure value also exceeds some international boundaries of many countries, such as United States - 90 dB (A) (OSHA, 1972), Portugal - 87 dB (A) (Directive, 2003), and Australia - 85 dB (A) (ACT, 2011), demonstrating the potentially harmful effect to the health of this level of exposure.

3.3. Audiology profile

The results obtained through the audiometric tests demonstrate that 63.9% (n = 23) had normal values in both ears and hearing thresholds are in the range of up to 25 dB for all frequencies (500Hz to 8000Hz). The other police officers, 36.1% (n = 13), have altered hearing thresholds (AHT) at high frequencies, suggesting that they can have NIHL, according to NR-7 (2013) instructions. It was observed that the service time is relatively more correlated with cases of hearing loss (Mann Whitney test, p-value = $9.511e^{-14}$ <0.05) than the age (Mann Whitney test, p-value = $1.005e^{-13}$ <0.05). Factor that corroborates with literature (Metidieri et al.; Yankaskas, 2013) and with the assumption that the service time in this category may be more harmful to hearing thresholds, accelerating the natural processes of aging of the human hearing system.

The AHT distribution presented results pointing prevalence as a service time function with values relatively higher than by age. Comparing the values obtained in the right ear with those of the left ear, the greater difference observed in the higher frequencies, more specifically at 4000Hz, 6000Hz and 8000Hz. Observing the age distribution of the sample, the lowest occurrence of AHT is verified in the group of 30-39 years (n = 16) with 11 years of service, in the frequencies of 6000Hz and 8000Hz. No threshold changes were observed at frequencies lower than 3000Hz, which indicates the non-occurrence of severe cases of difficulty in speech recognition (Mendes, 2013).

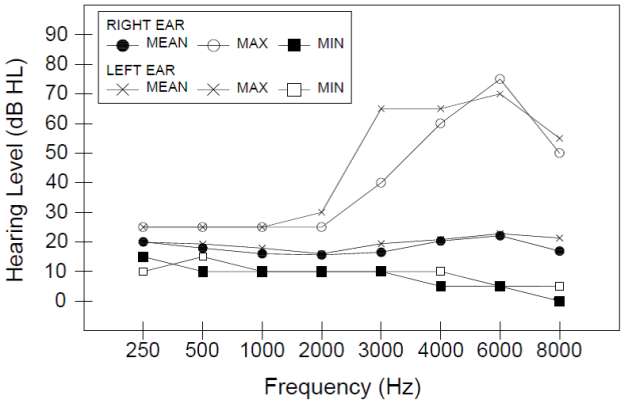

Figure 1. Average, maximum and minimum values of hearing thresholds obtained through audiometric tests

Figure 1 shows the curves with the average hearing thresholds (HT) of the right and left ears. In both ears, thresholds levels are above 25 dB, noticing only a mild increase in the frequency of 6000Hz.

Table 2. Correlation among service time, age and hearing thresholds

	Time Service				Age			
	Coefficient		p-value		Coefficient		p-value	
f (Hz)	RE	LE	RE	LE	RE	LE	RE	LE
500	0.227	0.273	0.182	0.106	0.043	0.245	0.799	0.149
1000	-0.098	0.057	0.569	0.737	-0.020	-0.056	0.905	0.714
2000	0.190	0.328	0.266	0.050	0.114	0.278	0.507	0.099
3000	0.458	0.408	0.004*	0.013*	0.317	0.306	0.059	0.068
4000	0.424	0.352	0.009*	0.035*	0.285	0.217	0.091	0.203
6000	0.422	0.170	0.010*	0.321	0.303	0.121	0.072	0.480
8000	0.452	0.156	0.005*	0.362	0.333	0.120	0.046*	0.484

RE - right ear; LE - left ear.
* p-value <0.05 for the Pearson correlation.

In relation to the maximum registered HT, the curve of the configuration found on the right ear suggests the occurrence of NIHL, due to the increase of HT within the frequencies of 3000Hz, 4000Hz and 6000Hz (respectively 40 dB, 60 dB, and 75 dB), with the improvement of HT in the 8000Hz frequency (50 dB); in the left ear, the curve appears as a suggestive case of NIHL, representing a mixed hearing loss caused by factors other than exposure to noise (Lloyd & Kaplan, 1978).

In this curve, there is an increase at 3000Hz (65 dB), becoming higher at 4000Hz (65 dB), and with a gentle decline at 6000Hz (70 dB). However, audiometric curves shown in Figure 1 for each ear do not report distinction between the values of hearing thresholds amended related to age and seniority, factor verified in Table 2.

Table 2 presents the results obtained by applying the Pearson correlation analysis (with α = 0.05) among AHT, age and service time. Significant values were identified at high frequencies (3000Hz, 4000Hz, 6000Hz and 8000Hz) depending on service time for the right ear. On the left ear, just the frequency of 3000Hz and 4000Hz suggested the occurrence of hearing loss cases in these results. Notwithstanding, depending on the age, only the frequency of 8000Hz was considered representative. In fact, the correlation coefficients are lower in relation to age than to service time. This finding can further confirm the influence of service time in determining the frame of hearing loss on these audiograms. Therefore, the results emphasize the premise that there is a positive and significant correlation between the service time mainly in the frequencies of 3000Hz and 4000Hz. These findings resemble those ones presented in the study of many authors found in the literature (Santos, Junchem & Rossi, 2008; Lesage et al., 2009; Guida et al., 2010; Guida, Diniz & Kinoshita, 2010; Heupa, Gonçalves & Coifman, 2011; Guida, Sousa & Cardoso, 2012; Metidieri et al.; Yankaskas, 2013), confirming the conclusion that changes in the HTs in these frequencies show the beginning of the NIHL frames.

In order to compare the HTs of police officers exposed to occupational noise during a workday with a population of similar age but without exposure to noise, without hearing loss history and natural reduction of HTs in function of aging, a comparison was drawn, presented in Figure 2, based on ISO 1999 (2013) data. This comparison between groups is recommended by the standard itself for studies on hearing threshold levels and determination of NIHL (Maia, 2002). The curves of HT selection of military police officers (drawn with a circle and an X in Figure 2) show the influence of occupational noise on the hearing ability of these professionals, which becomes more evident when compared with the HT of the population not exposed to noise.

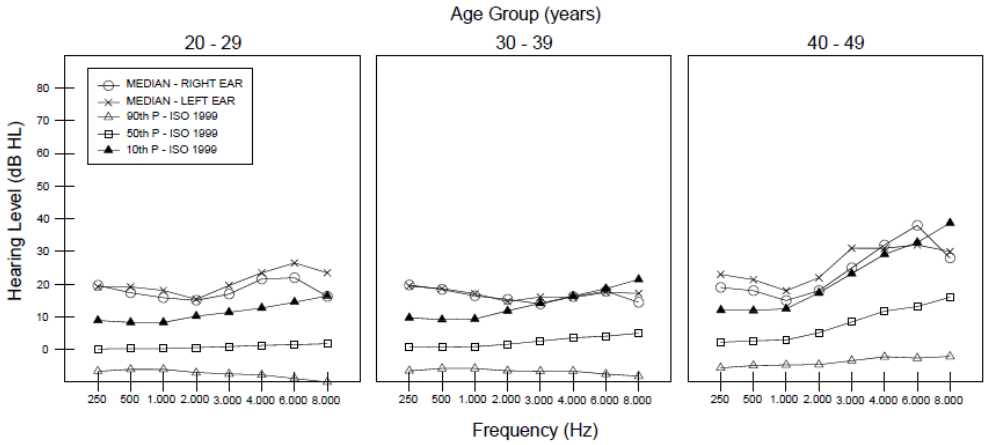

Figure 2. Comparison between the hearing thresholds of selected groups and ISO 1999 (2013) standard

In that sense, in the HTs of the 20 to 29 years old group, the frequencies of 4000Hz and 6000Hz are below 20 dB and are higher than those of the HT control group (-10 to 10 dB), which means that the effects of exposure to noise is beginning to reduce hearing capacity. However, in this scenario, there is no impairment of speech recognition. This finding of increased hearing thresholds shows that, with a service time of 5.5 years, it is possible to see changes in hearing acuity. In addition, in the left ear, the ascending configuration at high frequencies (3000Hz, 4000Hz and 6000Hz) seems more suggestive for the NIHL than in the right ear.

In the group of 30-39 years, the HTs of the exposed police officers in the frequencies of 3000Hz, 4000Hz and 6000Hz are aligned with those of the control group in the 10th percentile, presenting values below 20 dB in both ears. The curves indicate that there is a relative stabilization in hearing loss, despite the high service time (11 years) of these subjects. This corroborates the audiological findings of surveyed authors (Maia, 2002; Guida et al., 2010; Yankaskas 2013), indicating a stabilization of symptoms of NIHL after 10 years of continuous exposure. In the group of 40-49 years, there is a discrepancy between the settings of audiometric curves of each ear within this group. Hearing thresholds of the right ear represent a value of 40 dB at a frequency of 6000Hz, representing less hearing ability in the range of 6000Hz which suggests NIHL (Yankaskas, 2013; Metidieri et al. 2013).

In the curve of the left ear, the HTs suggest a configuration of mixed hearing loss, apparently without the dominance of the influence from occupational noise but, with the influence of other factors (non-occupational noise, diseases, sensitivity and predisposition). There is also an overlap of HTs in the frequencies of 4000Hz and 6000Hz (30 dB) with the curve of the 10th percentile from the control group.

The identification of an hearing threshold increase in the group with the shortest exposure time (20-29 years old) and the group with the longest exposure time (30-39 years old) may, according to Maia (2002) and Metidieri et al. (2013), direct mainly to preventive actions for these groups. Therefore, to confirm the statements made and to confirm the actual difference between the means of hearing in the control group and the group exposed at each frequency threshold, a t-Student test ($\alpha = 0.05$) was performed in order to compare the values between the two groups. It was thus possible to say that the mean hearing threshold is different (p-value <0.05) for each control group.

The classification audiometry results, according to the criteria Lloyd and Kaplan's (1978) revealed that 11.1% of the audiograms showed mild and moderate hearing loss at low frequencies (500Hz, 1000Hz and 2000Hz) and 19.5% at high frequencies (3000Hz, 4000Hz and 6000Hz). The audiogram has also showed a case of moderately severe hearing loss in the left ear. Approximately 69.4% had normal values, i.e., no indication of NIHL. There were no cases of hearing loss inducing difficulties in speech understanding. At high frequencies (3000Hz, 4000Hz and 6000Hz), the prevalence of cases in which the degree of hearing loss can be considered mild to moderate was higher in the left ear (n = 8) than in the right ear (n = 6). Nonetheless, these results can refer to mixed hearing loss, where the influence of other factors may not be excluded.

It was concluded that on this study, there is a sign of NIHL, probably due to the service time at the frequencies of 3000Hz, 4000Hz and 6000Hz, with a prevalence of unilateral loss of sensorineural type (Silman & Silverman, 1994). This reinforces the results found in other studies in the area of noise exposure and military policing, such as in Silva et al. (2004), Santos, Junchem & Rossi (2008), Guida et al. (2010), Guida, Diniz & Kinoshita (2011), Heupa, Gonçalves & Coifman (2011) and Guida, Sousa & Cardoso (2012).

4. CONCLUSIONS

This research on hearing thresholds in military police officers, points out, through the results of the audiograms, for the existence of NIHL in these professionals. The relationship between hearing thresholds modified with age or service time was significant within a 95% confidence interval, preliminarily indicating the influence that these variables may have on motorcycle police hearing quality. Registered hearing loss was higher in the group of police officers with less than 10 years of service and aged 20 to 29 years old. In the group whose participants had more than a decade of experience and older than 40 years, they have certainly backlog the exposure to noise. Even with the normal index on the results of the audiogram, one can see that corrective measures need to be taken to prevent the disqualification of these professionals as a result of exposure to noise, once hearing loss can compromise their performance and the performance of police activities in this professional group. Thus, this study indicates the importance of monitoring auditory health conditions of military police officers.

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