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# Auditory effects and communication disorders in an aerial patrol group

Efeitos auditivos do ruído e dificuldades de comunicação em um grupamento de radiopatrulha aérea

Efectos auditivos y dificultades de comunicación en un grupamento de radiopatrulha aérea

Vera Cecilia Gelardi\*  
Ana Claudia Fiorini\*\*

## Abstract

**Introduction:** noise exposure can cause auditory and non-auditory effects. **Objective:** To study auditory effects and communication disorders among aerial patrol group. **Method:** observational, cross-sectional study with 50 police officers with a mean age of 39 years and a mean working time of 16.7 years. Procedures include anamnesis, questionnaire, visual inspection of the external auditory canal and audiometric assessment. **Results:** 96% of the police believe that the working environment is noisy and cite radio control (air and ground) and other aircraft as the main sources. The main complaints were: stress (46%), communication disorders (40%), lack of attention (32%), annoyance (28%), tinnitus (32%), full hearing (26%) and discomfort for high levels (32%). The audiometry showed 35 soldiers classified as normal hearing (70%), eight as suggestive of noise induced hearing loss (16%) and seven (14%) with other causes. There was a statistical association between “Difficulty of communication with others” and the variables: noise from other aircraft, stress, annoyance, lack of attention, discomfort, tinnitus and work efficiency. In logistic regression analysis, individual reports of discomfort, the chance that had difficulty of communication with others is 21 times (CI 3.87 to 113.88). **Conclusion:** The military

\*Pontificia Universidade Católica de São Paulo, PUC-SP, São Paulo-SP, Brazil.

\*\*Universidade Federal de São Paulo, UNIFESP, São Paulo-SP, Brazil.

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**Correspondence address:** Vera Cecilia Gelardi - gelardivc@gmail.com

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believes that the work environment is noisy and has high incidences of health problems. The difficulty of communication was statistically associated with noise and various effects on health.

**Keywords:** Hearing; Noise; Adverse Effects.

## Resumo

**Introdução:** O ruído pode ocasionar problemas auditivos e não auditivos em trabalhadores. **Objetivo:** estudar os efeitos auditivos e as dificuldades de comunicação em militares de um grupamento de radiopatrulha aérea. **Método:** estudo observacional, do tipo transversal de inquérito. A amostra foi de 50 policiais militares com média de idade de 39 e tempo de trabalho de 16,7 anos. Os procedimentos incluíram anamnese, questionário, inspeção visual do meato acústico externo e avaliação audiométrica. **Resultados:** 96% dos policiais acham o ambiente de trabalho muito ruidoso e citam os rádios controle (aéreo e terrestre) e as outras aeronaves como as principais fontes. As principais queixas foram: estresse (46%), dificuldade de comunicação (40%), falta de atenção (32%), incômodo (28%), zumbido (32%), sensação de plenitude auricular (26%) e intolerância a sons intensos (32%). As audiometrias tonais indicaram 35 militares classificados como Normal (70%), oito como sugestivos de PAIR (16%) e sete (14%) como Outras Causas. Houve associação estatística entre “O ruído do ambiente dificulta a comunicação com os outros?” e as variáveis: ruído de outras aeronaves, estresse, incômodo, falta de atenção, irritabilidade, zumbido e eficiência no trabalho. A análise de regressão logística indicou que quando o indivíduo relata incômodo, a chance de ele ter dificuldade para se comunicar com os outros é 21 vezes (IC 3,87 - 113,88). **Conclusão:** os militares consideram o ambiente de trabalho ruidoso e apresentam alta ocorrência de queixas de saúde. A dificuldade para se comunicar foi estatisticamente associada ao ruído no ambiente de trabalho e a diversos efeitos na saúde.

**Palavras-chave:** Audição; Ruído; Efeitos Adversos

## Resumen

**Introducción:** El ruido puede traer efectos auditivos y no auditivos **Objetivo:** Estudiar los efectos auditivos y las dificultades de comunicación en un grupamento de radiopatrulha aérea. **Método:** estudio observacional y transversal con 50 agentes de policía con una edad media de 39 y un tiempo medio de trabajo de 16,7 años. Los procedimientos incluyen anamnesis, cuestionario, la inspección visual del conducto auditivo externo y la evaluación audiométrica. **Resultados:** El 96% de la policía creen que el ambiente de trabajo es ruidoso y citan el control de radio (aire y tierra) y otras aeronaves como las principales fuentes. Las principales quejas son: estrés (46%), dificultades de comunicación (40%), la falta de atención (32%), molestia (28%), zumbido (32%), el oído está lleno (26%) y la intolerancia sonidos intensos (32%). La audiometría mostró 35 militares clasificados como normales (70%), ocho como sugerente de pérdida de audición inducida por ruido (16%) y siete (14%) con otras causas. Hubo una asociación estadística entre “El ruido ambiental dificulta la comunicación con los demás” y las variables: ruido de otras aeronaves, estrés, molestia, falta de atención, irritabilidad, tinnitus y eficiencia en el trabajo. Análisis de regresión logística indicó que cuando los informes individuales de molestia, la oportunidad que tenía dificultades para comunicarse con los demás es 21 veces (IC 3,87 a 113,88). **Conclusión:** Los militares creen que el ambiente de trabajo es ruidoso y tienen altas incidencias de problemas de salud. La dificultad de comunicación se asoció estadísticamente con el ruido y diversos efectos sobre la salud.

**Palabras clave:** Audición; Ruído; Efectos Adversos

## Introduction

Noise is present in workplaces, in leisure activities and on the streets of large cities, representing a major public health issue. Continuous exposure to noise can cause hearing problems such as tinnitus, hearing loss and noise annoyance, and non-hearing problems like discomfort, nervousness, irritability, stress, decreased attention and concentration and sleep disturbances.<sup>1</sup>

The assessment of auditory effects of exposure to noise involves the elaboration of a cause-and-effect diagram, with measurement of the history of noise exposure and audiological assessment<sup>2</sup>. However, regarding the analysis of non-auditory effects, this association is more complex and cannot be measured in this way.<sup>2</sup> Regardless of its level, noise may decrease the levels of attention and concentration of workers, with impact on the safety and efficiency of work activities<sup>3</sup>

Various professional categories are exposed to noise during work activities, such as military police (MP). These professionals may be exposed to both continuous and/or intermittent noise (radio communicators, sirens on police cars and others), and noise impact during the use of firearms.

Research involving military personnel identified a high occurrence of audiometric abnormalities (24-39%) suggestive of noise-induced hearing loss (NIHL) and increased complaints of tinnitus, depending on the length of time in the profession<sup>4,5, 6, 7,8,9, 10,11</sup>. However, there are few studies on the possible impact of these hearing losses on the performance of military functions. During the exercise of their professional activities, policemen are subjected to high auditory demands, and any change can cause verbal communication difficulties, leading to increased stress and jeopardizing work performance.<sup>(12,13,14,15)</sup>

Due to the importance of assessing the impact of auditory disorders on the exercise of professional activities, the present study aimed to investigate auditory effects and communication difficulties in the military personnel of an air patrol unit.

## Methods

Observational and cross-sectional survey with the population of an Air Patrol unit (GRPA), a special operational unit of the military police, at

Campo de Marte Airport - Hangar João Negrão, SP. The study was approved by the Research Ethics Committee, under number CAEE 524.274. Prior to the initial procedures, all the participants were clarified on the study, and those who agreed to participate, signed the informed consent form.

The military police GRPA is composed of administrative and operational personnel. The services provided include support to urban and road patrol, aeromedical rescue, environmental inspection and transportation of authorities, among others. The group has 10 military bases in the state of São Paulo, and rotary wing aircraft, AS350 (Eagle helicopters), are used in military operations. The operational unit is composed of pilots, crew, flight nurses and flight mechanics.

The GRPA of the São Paulo unit is composed of 225 military police officers. However, considering the inherent military activities, which include emergency situations, paid rest periods, unexpected displacement to other bases of the state, among others, the sample consisted of 50 military policemen.

Procedures for data collection included anamnesis, administration of a questionnaire on health effects from noise, visual inspection of external auditory meatus and audiometric evaluation.

The subjects were told to have an auditory rest of at least 14 hours before the tests, according to the recommendations of Regulation 7 (NR-7) of the Ministry of Labor and Employment (1998).<sup>16</sup> Inspection of the external auditory meatus was initially performed to check for any obstruction that could interfere with the tests. In case of obstruction, the subjects were referred to the Hospital of Aeronautics of São Paulo (HASP) for consultation with an otorhinolaryngologist and subsequently returned for the examination.

Prior to undergoing pure tone audiometry, the subjects completed a printed questionnaire including questions on personal data, auditory and non-auditory complaints, noise annoyance and noise disturbing communication during work. The questionnaire on the effects of noise was adapted to Portuguese by Ferreira (2013),<sup>17</sup> based on the instrument of Juang, Lee and Chang (2010).<sup>18</sup> Adaptation for military personnel was made by the researchers, based on a pilot study with 10% of the sample. After analysis of the pilot study, the instrument was adjusted to the sample of the present research.

The instrument was subdivided into seven sections: sources of noise, subjective perception of noise, effects of noise on emotion and physiology, experience of noise inside and outside the working environment and impact of ambient noise on work performance. All sections presented dichotomous responses and Likert scale responses, namely “nothing”, “very little”, “more or less”, “quite” and “extremely”.

Pure tone audiometry was performed using both air conduction at the frequencies of 250 Hz, 500 Hz, 1 kHz, 2 kHz, 3 kHz, 4 kHz, 6 kHz and 8 kHz and bone conduction (500 Hz to 4 kHz), when necessary. For these procedures, an Interacoustics Clinical Audiometer AC40 and SÃO LUIZ Audiometric Booth were used, and both met the requirements of NR-7 (1998).<sup>16</sup> The tests were conducted in the hangar of GRPA management, in a soundproof room located far from the airfield and the aircraft maintenance area.

The audiograms were classified into groups as Normal, Suggestive of NIHL and Other causes, as follows:

- Normal: all bilateral thresholds equal to or less than 25 dB HL.
- NIHL (audiograms suggestive of noise induced hearing loss): individuals with configuration of hearing loss (thresholds higher than 25 dB HL) in at least one ear, at frequencies between 3 and 6 KHz, according to the provisions of NR-7 (1998).<sup>16</sup>
- Other causes: audiograms suggestive of hearing loss, though not suggestive of NIHL in descending curve.

This classification was neither diagnostic nor technical. It was merely used for data analysis.

The data collected were typed in an Excel spreadsheet and transformed into a database, suitable for statistical analysis. Descriptive statistics and then statistical analysis were performed. For statistical analysis the following outcome was defined: **Does ambient noise make communication with others difficult?**

Statistical analysis was done with Minitab statistical software version 16 and Excel 2010. The analysis started with the application of chi-square tests of independence.<sup>19</sup> The significance level for each test was equal to 10%, in order to select variables for the logistic regression model.<sup>20</sup> All variables with more than two categories were dichotomized. The responses “nothing” and “very

little” were categorized as “little” and the variables “more or less”, “quite” and “extremely” as “very much”.

## Results

The study sample was composed of 50 military personnel, 47 (94%) males and three (6%) females. Regarding their functions, seven were pilots (14%), nine co-pilots (18%), 18 crew (36%) and 16 mechanics (32%). The age ranged from 28 to 52 years, with a mean and median of 39 and a standard deviation of 6.7 years. Regarding length of time working as a military policeman, it ranged from 6 to 30 years, mean of 16.7 and standard deviation of 7.1 years.

Concerning the frequency of noise in the aircraft, 48 (96%) answered “always” and only two (4%) reported “never” or “rarely”. The main sources of noise inside the aircraft were radio control of air traffic ( $n = 41 - 82\%$ ), radio control of calls reporting occurrences ( $n = 38 - 76\%$ ), people talking and door open to receive instructions (both with  $n = 25 - 25\%$ ) and air conditioning ( $n = 2-4\%$ ). The main sources of noise outside the aircraft were motor and rotors (both  $n = 50-100\%$ ), other aircraft ( $n = 26-52\%$ ), loud sound ( $n = 22-44\%$  20-40%) and traffic ( $n = 13-26\%$ ).

In the section on non-auditory complaints related to exposure to noise, the following responses were obtained: it is stressful (46%), makes communication difficult (40%), causes lack of attention (32%) and causes discomfort (28%).

The auditory complaints reported on the questionnaire were tinnitus (32%), ear fullness (26%) and noise annoyance (32%).

Regarding the results of pure tone audiometry, 35 military personnel were classified as Normal group (70%), eight as suggestive of NIHL (16%) and seven (14%) as Other Causes. It is worth mentioning that all those classified as Other Causes presented a descending curve for hearing loss.

As explained in the Method, the statistical analysis was performed for the outcome “Does ambient noise make communication with others difficult?”. The level of significance adopted in each test was equal to 10%, since the intention was to select variables for the regression models. Table 1 shows evidence of an association between the variable “Does ambient noise make communication with others difficult?” and the following variables:

Other aircraft ( $p = 0.039$ ), i.e., the percentage of individuals who think ambient noise make communication with others difficult is greater among those who think other aircraft are a major source of noise outside the aircraft (84.6%) than among those who do not think other aircraft are a major source of noise outside the aircraft (58.3%).

Does ambient noise make you feel stressed? ( $p = 0.030$ ), i.e., the percentage of individuals who think ambient noise makes communication with others difficult is greater among those who feel stressed (87.0%) than among those who do not feel stressed (59.3%).

Does ambient noise affect your concentration? ( $p = 0.002$ ), i.e., the percentage of individuals who think ambient noise makes communication with others difficult is higher among those who think that ambient noise affect concentration (100.0%) than among those who think that ambient noise does not affect concentration (58.8%).

Does ambient noise annoy you? ( $p < 0.001$ ), i.e., the percentage of individuals who think ambient noise make communication difficult is higher

among those who think ambient noise is annoying (93.3%) than among those who think ambient noise is not annoying (40.0%).

Does ambient noise irritate you? ( $p = 0.009$ ), i.e., the percentage of individuals who think ambient noise make communication with others difficult is higher among those who think ambient noise irritates them (100.0%) than among those who think ambient noise does not irritate them (62.2%).

Does ambient noise make you feel tinnitus? ( $p = 0.013$ ), i.e., the percentage of individuals who think ambient noise makes communication with others difficult is greater among those who think ambient noise cause tinnitus (100.0%) than among those who think ambient noise does not cause tinnitus (63.2%).

Does noise affect your performance at work? ( $p = 0.019$ ), i.e., the percentage of individuals who think ambient noise make communication with others difficult is greater among those who think that noise affects their performance at work (100.0%) than among those who think noise does not affect their performance at work (64.1%).

**Table 1.** Distribution of frequencies between the variable "Communication difficulty with others" and some variables of interest for which the  $p$  value of association test <sup>1</sup> was less than 10%.

Does the noise interfere with your communication with others?	Little		Much		Total		value p 2
	n	%	n	%	n	%	
Other aircraft							
No	10	41,7	14	58,3	24	100,0	0,039*
Yes	4	15,4	22	84,6	26	100,0	
Does the noise make you stressed?							
Little	11	40,7	16	59,3	27	100,0	0,030*
Much	3	13,0	20	87,0	23	100,0	
Does the noise cause you lack of attention?							
Little	14	41,2	20	58,8	34	100,0	0,002*
Much	-	-	16	100,0	16	100,0	
Does the noise annoy you?							
Little	12	60,0	8	40,0	20	100,0	<0,001*
Much	2	6,7	28	93,3	30	100,0	
Does the noise irritate you?							
Little	14	37,8	23	62,2	37	100,0	0,009*
Much	-	-	13	100,0	13	100,0	
Does the noise cause tinnitus?							
Little	14	36,8	24	63,2	38	100,0	0,013*
Much	-	-	12	100,0	12	100,0	
Does noise interfere with your work efficiency?							
Little	14	35,9	25	64,1	39	100,0	0,019*
Much	-	-	11	100,0	11	100,0	

1. For the application of the association test, the Do not Know category has been eliminated from the issues in which it was made. In addition, all variables were dichotomized. 2.\* =  $p < 0,05$ .

In order to select the variables most associated with the outcome variable a logistic regression model was adjusted <sup>20</sup>. The variable “Does ambient noise make communication with others difficult?” was used as the response variable and the seven variables were related to it (Table 1) as explanatory variables. The variable selection method was the method backward <sup>21</sup>. As shown in the results in Table 1, it can be seen that the variable “Does ambient noise annoy you? is most

associated with the variable “Does ambient noise make communication with others difficult?”. Table 2 also shows the odds ratio and its respective confidence interval (CI), calculated with a confidence coefficient of 95%. Interpretation of the odds ratio is as follows: when the individual says he/she is annoyed with ambient noise, the probability of him/her having difficulty communicating with others is 21 times greater than the probability of not having difficulty communicating with others.

**Table 2.** Estimates, p values, odds rate and 95% confidence interval for odds rate relative to logistic regression parameters.

Parameter	Estimates	Standard error	Value P	Odds Rate	CI (95%) for odds rate	
					Lower Limit	Upper Limit
Interceptor	-0,405	0,456	0,374			
Annoyance	3,045	0,863	<0,001	21,00	3,87	113,88

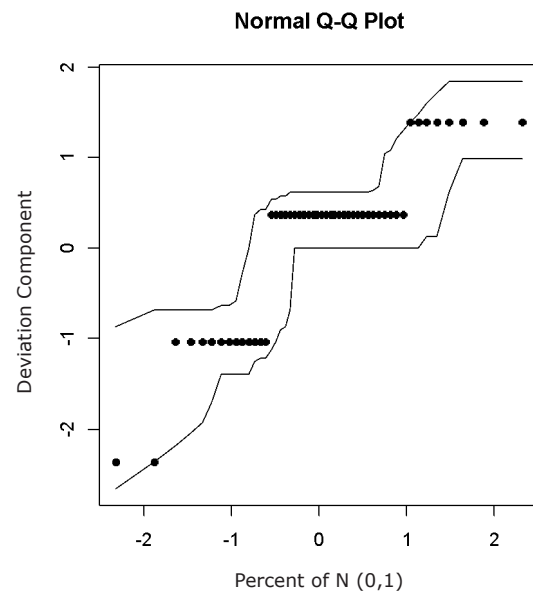
C statistic of Hosmer and Lemeshow (2000) test to measure the adjustment of logistic regression models could not be calculated. Therefore, in order to check the goodness of fit of the logistic regression model, a normal probability plot was constructed (Figure 1). Since all the points fall within the confidence bands, the model can be considered well fit.

**Discussion**

The sample of the military personnel that participated in the present study was mostly composed of male individuals (47) with a mean age of 39 years. These characteristics are similar to other studies with military personnel <sup>22,23</sup>.

Most participants (96%) said they were exposed to loud noise in the aircraft, which made it difficult for them to focus on their activities. The results corroborate other studies that also emphasized the impact of noise on attention levels of these professionals. <sup>12,15,24,25,26</sup>

Regarding the main sources of noise inside and outside the aircraft, the most cited were radio control systems (air and land-based) and other aircraft. These data corroborate a study on radio sounds and concluded that this type of communication should be clear, and quality improves the effectiveness of military operations <sup>27</sup>. In addition,



**Figure 1.** Normal Probability

according to reports by the military that participated in the present research, the number of helicopters in circulation has grown significantly in recent years, as well as that of commercial aviation flights, increasing air traffic noise, mainly where the air patrol unit (Campo de Marte) is located. These data corroborate many studies that link air traffic

as one of the most important sources of noise pollution<sup>2,13,27,28,29,30</sup>.

The reported hearing complaints, in order of greatest occurrence, were: tinnitus and intolerance to intense sounds (both 32%) and ear fullness (26%). Such complaints were also the most frequent in several studies, and were stressed as the most common among the military personnel.<sup>5,6,9,23</sup>

Complaints of stress, difficult communication, lack of attention and annoyance were very frequent and can cause several impacts on the performance of the military during the exercise of their functions. Many studies indicate an important relationship between these complaints and increased fatigue and concentration difficulties, factors that directly contribute to the performance of this population. In general, the authors point out that noise, need to focus on their demanding tasks and responsibility for complex missions corroborate the worsening of working conditions<sup>12,13,14,15,24,27</sup>.

In the present study, 30% of the military personnel had abnormal audiograms and were classified in the NIHL groups (16%) and Other causes / descending (14%). These data were similar to those obtained in several studies with military personnel and indicate a high incidence of hearing loss when compared to other professional categories,<sup>4,6,9,10,23</sup>.

In general, statistical analyzes showed several associations for the specific outcome. Statistically significant associations with a set of independent variables, especially those related to the presence of ambient noise were observed in the selection of the dependent variable "difficulty communicating with others". The variables: tinnitus, lack of attention, annoyance, stress and irritation have been cited in several relevant studies. Some reinforced the fact that people talking is a source of noise that reduces the ability to clearly understand information and thus produce significant associations between ambient noise, stress and annoyance<sup>2,14,17,18,24,27</sup>.

As observed in this study, difficult communication caused by competing noise was also identified in other studies. A study with firefighters found that 16.9% of them reported difficult communication with others due to ambient noise<sup>24</sup>. Another research that assessed the effectiveness of radio communication in military pilots found that 14% reported problems such as overlapping speech, background noise, among others, mainly in helicopter operations<sup>27</sup>. There is evidence of a statistically significant association between noise, communica-

tion, stress and annoyance during military professional activities<sup>12</sup>.

For workers, like the GRPA military personnel, who must be able to clearly understand information conveyed by a main source while performing their specific tasks, communication is crucial for the appropriate implementation of operations and flight safety. Moreover, the need for communication without interference is a matter of flight safety for the crew of the aircraft, and also for the population assisted by these professionals<sup>27</sup>.

Therefore, noise can influence the ability of workers to concentrate. In the specific case of GRPA military that perform high-risk activities, lack of attention can lead to fatal accidents<sup>27</sup>.

Regarding the result of the logistic regression model, it showed that the probability of difficult communication increases 21 times when the individual reports being annoyed by ambient noise. The present study whose participants were military policemen of an air patrol unit revealed great concern with stressful agents in the environment and the organization of the work activities performed by these professionals<sup>30</sup>.

Alertness and constant attention are part of the work routine of these policemen, and this is exacerbated among military pilots<sup>14,27</sup>. Noise interferes with the communication of these professionals and also poses a risk to their hearing. Thus, the use of proper hearing protection by workers is essential during the exercise of military activities, especially for the crew of aircraft<sup>4,5,6,8,9,26,27</sup>.

The presence of ambient noise is another stressful agent in the work environment of military personnel of the referred air patrol group (GRPA), and the annoyance generated by such noise may aggravate the stress of these professionals, jeopardizing the safety of all the individuals who need the services provided by this corporation.

## Conclusion

- The military personnel consider their working environment very noisy and reported frequent auditory and non-auditory complaints.
- The incidence of hearing loss was similar to that observed in other studies with military personnel.
- Difficult communication with others is mainly related to annoyance resulting from ambient noise, but also to several health effects from noise.

- Proper hearing protection suitable to the needs of aircraft crew should be used to ensure good communication and safety during flights.

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