

Tatiana Rodrigues Garcia<sup>1</sup>  
Maria Isabel Kós Pinheiro de Andrade<sup>1</sup>  
Silvana Maria Frota<sup>1</sup>  
Maria de Fátima Miranda<sup>1</sup>  
Raphael Mendonça Guimarães<sup>1</sup>  
Armando Meyer<sup>1</sup>

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### Correspondence address:

Tatiana Rodrigues Garcia  
Serviço de Fonoaudiologia  
R. Rodolpho Paulo Rocco, 255,  
3º andar, Cidade Universitária,  
Ilha do Fundão, Rio de Janeiro (RJ),  
Brazil, CEP: 21941-913.  
E-mail: tatirodriguesgarcia@gmail.com

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# Cochlear function in students exposed to pesticides

## *Função coclear em escolares expostos aos agrotóxicos*

### ABSTRACT

**Purpose:** To estimate the degree of association between exposure to pesticides and the risk of alteration in cochlear function in students exposed to pesticides. **Methods:** This study evaluated individuals aged 8 to 30, of both genders, residing in an area of heavy pesticide use in the town of Nova Friburgo, Rio de Janeiro State. Each study participant answered a questionnaire to assess their degree of pesticide exposure. To evaluate cochlear function, audiometry exams were performed, including transient evoked otoacoustic emissions (TEOAEs) and distortion product otoacoustic emissions (DPOAEs). **Results:** The TEOAE responses were on average lower at higher frequencies, especially at 2.0 and 4.0 kHz, and lower at these frequencies among the most exposed individuals. A similar pattern was observed for DPOAE responses. The lowest response level in the DPOAE tests was observed at the frequency of 6 kHz in the group with the highest exposure score. The proportion of failures observed at more than one frequency in the TEOAE tests on the right ear was significantly higher in the highest exposure group when compared to the lowest exposure group. In the DPOAE test, the rate of failure was also greater in the group with highest exposure when compared to that of lowest exposure. **Conclusion:** The results suggest that exposure to pesticides can significantly contribute to alterations in cochlear function in individuals with preserved audiometric thresholds.

### RESUMO

**Objetivo:** Estimar a magnitude da associação entre a exposição a agrotóxicos e o risco de alteração da função coclear de estudantes expostos a agrotóxicos. **Método:** Neste estudo, foram avaliados indivíduos entre 8-30 anos, de ambos os gêneros, residentes em área de intensa utilização de agrotóxicos no município de Nova Friburgo, Estado do Rio de Janeiro. Cada participante do estudo respondeu a um questionário para aferir o grau de exposição a agrotóxicos. Para avaliação da função coclear, foram realizados os exames de audiometria, emissões otoacústicas evocadas por estímulo transiente (EOAET) e por produto de distorção (EOAPD). **Resultados:** As respostas das EOAET foram, em média, menores nas altas frequências, especialmente 2,0 e 4,0 kHz, e, nestas frequências, também menores entre os indivíduos mais expostos. Padrão similar foi observado para as respostas das EOAPD. Para estas, o menor nível de resposta foi observado na frequência de 6 kHz, no grupo com maior escore de exposição. A proporção de falhas observadas em mais de uma frequência nas EOAET, na OD, no grupo de maior exposição, foi significativamente superior àquela observada no grupo menos exposto. No teste das EOAPD, o percentual de falhas também foi superior no grupo de maior exposição, quando comparado ao de menor exposição. **Conclusão:** Os resultados sugerem que a exposição a agrotóxicos pode contribuir significativamente para alterações da função coclear de indivíduos com limiares audiométricos ainda preservados.

Study carried out at Instituto de Estudos em Saúde Coletiva, Universidade Federal do Rio de Janeiro – UFRJ - Rio de Janeiro (RJ), Brazil.

<sup>1</sup> Universidade Federal do Rio de Janeiro – UFRJ - Rio de Janeiro (RJ), Brazil.

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## INTRODUCTION

In Brazil, the process of agricultural modernization occurred during the military dictatorship, with a view to increase crop production. This model was based on the extensive use of chemical inputs such as fertilizers and pesticides, as well as the mechanization for crops on large areas of land. This entire process is considered as being a prime source of contamination of ecosystems, laborers and the local population<sup>(1)</sup>.

In this context, instances of pesticide poisoning are registered every year. However, these cases are underreported, thus undermining the scale of the problem. Rural production and the use of pesticides grow each year. Aside from cases of acute poisoning, pesticides are commonly associated with several other health problems<sup>(2)</sup>, among them hearing problems<sup>(3)</sup>.

Hearing loss is part of the natural aging process. However, it may occur early in industrialized countries due to exposure to occupational noise and ototoxic chemicals<sup>(4)</sup>.

Hearing loss from ototoxicity usually affects high frequencies<sup>(5)</sup>. These frequencies are situated between 5 and 10 mm from the oval window and are the most vulnerable. This may be associated with the resonance characteristics of the outer and middle ear, with the mechanical and anatomical characteristics of the cochlea or with its blood supply<sup>(6)</sup>.

The use of pesticides is no longer an issue specifically related to crop production and is now a public health concern<sup>(7)</sup>.

Epidemiological studies have suggested a higher prevalence of hearing loss among farmers exposed to noise, possibly starting in childhood<sup>(8,9)</sup>. However, studies on the toxic effects of pesticides on the auditory system are still scarce. For example, it is known that rodents exposed to pesticides present morphological alterations to their cochlea in the three spirals analyzed, in the cells of the saccule and utricle<sup>(10)</sup>.

Some studies carried out with evoked otoacoustic emissions (EOAE) in individuals exposed to noise found a reduction in the level of responses at the frequencies studied<sup>(11,12)</sup>. These alterations may occur even if there is no alteration to audiometric thresholds<sup>(13)</sup>. Therefore, the EOAE exam may be used for the early detection of hearing loss. Thus, this study aimed to estimate the magnitude of the association between exposure to pesticides and the risk of alteration in cochlear function, by way of evoked otoacoustic emissions in students exposed to pesticides from an agricultural area of the municipality of Nova Friburgo, RJ, with preserved audiometric thresholds.

## METHODS

### Study population and location

This cross-sectional study was held in the region of the São Lourenço micro-basin in Nova Friburgo, RJ. This region is located 1000-1200 meters above sea level and is surrounded by the Serra do Mar and Serra dos Órgãos mountain ranges. The school where this study was held is in this region. The choice of the students from this school to be the study population was due to the school's teaching model, which intersperses periods

of lessons with periods without lessons, in which students help their parents with agricultural activities.

All students from the school in the São Lourenço micro-basin were invited to participate in the study. Thus, an initial convenience sample was established, comprising 243 students of both gender and aged between 8 and 30. Of these, 22 students were excluded for alterations to their audiological thresholds, 9 were excluded due to having cerumen or foreign bodies in their ear canal and 7 others were excluded based on tympanograms with type "B" or "C" curves. Therefore, a total of 205 participants progressed to the evaluation of evoked otoacoustic emissions. Age ranges were divided into 8 to 19 years old (children/adolescents) and 20 to 30 years old (adults).

### Ethical aspects

The study considered the ethical aspects recommended by Resolution 196 / 96 regarding Studies involving human individuals, including among others the obtaining of the Free and Informed Consent of the individuals. This assures that the participation of individuals will not entail anything that could lead to their physical, mental, moral, intellectual, social, cultural or spiritual harm.

All individuals who accepted to participate in the study signed the Free and Informed Consent form. The study was submitted and approved, following the rules of the Research Ethics Committee of the Institute of Collective Health, UFRJ, numbered 67/2011.

### Data collection

After selection, the students were invited to complete a questionnaire (Appendix A), adapted from the *Agricultural Health Study*<sup>(14)</sup>, to measure their degree of pesticide exposure. The application of the questionnaire was carried out by two previously trained interviewers. The questionnaire also included questions related to personal information, occupational information and life habits, general health information and hearing information. The time, type of exposure, work process and type of pesticide used were also investigated. The questionnaire allowed for the calculation of a pesticide exposure score, which varied from 0 (least exposed) to 63 (most exposed). The participants were then sorted into 4 exposure groups in accordance with the score quartiles.

### Audiological exam

#### *Meatoscopy*

All participants were submitted to meatoscopy using a Heine Mini 2000 clinical otoscope, with a view to inspecting the ear canal. Individuals that had cerumen and alterations to the tympanic membrane were excluded from the study and sent for medical examination.

#### *Basic audiological evaluation*

The audiological evaluations were held in a soundproof booth, made specifically for Audiometry, using an InteracousticsAC30 audiometer. Tonal threshold audiometry was

performed to measure auditory thresholds. The threshold test was carried out through air and through bone. Participants were also submitted to speech recognition threshold (SRT) evaluation and percentage of speech recognition (PSR) evaluation.

The individuals with an auditory threshold higher than 20 dB HL were excluded from the study and were therefore not submitted to otoacoustic emissions evaluation.

#### Impedance audiometry

Evaluation of the middle ear was performed using an Interacoustics AZ7 impedance audiometer. Participants with middle ear alterations, characterized by type “B” and “C” curves, were excluded from the study and referred to medical service. Therefore, only those students with a type A tympanogram, where the peak admittance ranged from 0 to 100 daPa, were entered the study.

#### Evoked Otoacoustic Emissions (EOAEs)

In assessing EOAEs, an Otodynamics OAS EZ Echoport ILO288 was used, connected to a laptop computer. The tests were performed in a soundproof room. An SGD General TE+DPOAE probe was connected to the machine and inserted into the ear canal, after inspection. The examination was performed on both ears of each participant.

#### Transient Evoked Otoacoustic Emissions (TEOAEs)

TEOAEs were recorded in response to a click stimulus. The stimulus intensity was about 80 dB SPL, with a reproducibility greater than 50% and probe stability equal or greater than 70%. The protocol used was “TE Screen 70% to 3/4 frequencies” evaluating the frequency bands of 1, 1.5, 2, 3 and 4 kHz. However, the frequency of 1 kHz was not analyzed as it presented an alteration to the reproducibility and amplitude of the signal-to-noise (SNR) ratio. Response level of the SNR ratio equal to or greater than 3 dB SPL was defined as one of the criteria for the presence of response. The individual needed present a response in at least three frequency bands, with a response at the 4-kHz band being obligatory. A response obtained per the criteria above was considered as a “pass,” while examinations not meeting these criteria were considered “failures”<sup>(15)</sup>.

#### Distortion Product Otoacoustic Emissions (DPOAE)

The evaluation was performed at the frequencies of 1.5, 2.0, 3.0, 4.0 and 6.0 kHz. The protocol used two levels of intensity: L1 = 65 dB SPL and L2 = 55 dB SPL. Presence of a response was characterized by an SNR ratio equal to or greater than 6 dB SPL<sup>(16)</sup>.

The individual should present a response in at least four frequency bands, with a response at the 4 kHz and 6 kHz bands being obligatory. A response obtained per the criteria above was considered as a “pass,” while examinations not meeting these criteria were considered “failures”.

## Statistical analysis

To analyze the data, participants were grouped per the quartiles of pesticide exposure scores. EOAE responses were then verified in each quartile, as well as the variables of gender and age. Analysis of variance (ANOVA) was used to discriminate the mean responses obtained in each exposure group. Pearson’s chi-square test was used for the analysis regarding the “pass/fail” criteria for the EOAE in each ear and in the analysis of the SNR ratio by frequency range. Finally, a logistic regression analysis was performed to calculate the odds ratio (OR) of absence of response for TEOAE and DPOAE for each group of pesticide exposure, using the first quartile (least exposed) as a reference.

## RESULTS

Table 1 shows the main characteristics of the study population. Of the 205 students evaluated, 78% worked in agriculture and of these, 69.3% reported exposure to pesticides. There was a predominance of individuals aged 8-19 years (89.8%) and equivalence in relation to gender.

Table 2 shows the mean, median and standard deviation for the SNR ratio of TEOAE and DPOAE, per the quartiles of pesticide exposure. Regarding TEOAE, it was observed that the larger the exposure, the lower the responses, both for mean and median values, especially between the frequencies of 2.0 and 4.0 kHz. However, this effect was not detectable by the ANOVA test. As for the DPOAE test, similar results were observed, i.e., lower mean and median responses among the most exposed individuals; however, this effect was more intense at the highest frequency (6 kHz) where the ANOVA test revealed a *p* value of marginal significance.

**Table 1.** Main features of the population studied in relation to gender, age range, noise exposure, solvent exposure, work in agriculture and pesticide exposure, (N=205)

Variable	N	%
<b>Gender</b>		
Female	99	48.3
Male	106	51.7
<b>Age Group</b>		
8-19 years	184	89.8
20-30 years	21	10.2
<b>Exposure to noise*</b>		
No	159	77.6
Yes	46	22.4
<b>Exposure to solvents**</b>		
No	182	88.3
Yes	23	11.2
<b>Work in agriculture</b>		
No	45	22.0
Yes	160	78.0
<b>Exposure to pesticides</b>		
No	63	30.7
Yes	142	69.3

\*Driving trucks, tractors and buses, grinding food, or welding; \*\*Solvents used for cleaning equipment after use

Figure 1 shows the results of the SNR ratio and the “pass/fail” criteria for TEOAE and DPOAE for each quartile, subdivided by exposure score and ear. Students who reported higher exposure (quartile IV) presented a significantly higher number of alterations at 4 kHz for TEOAE in the right ear, when compared to the less

exposed students (Group I). These students also had a higher frequency of failures than the comparison group ( $p < 0.05$ ).

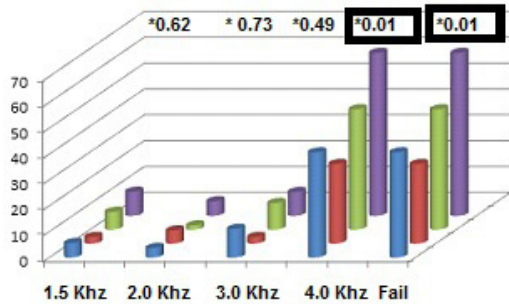
In the DPOAE test, the failure rate was significantly higher in the more exposed groups (quartiles III and IV) at the frequency of 6 kHz and in the left ear. For the DPOAE responses, the

**Table 2.** Measures of Central Tendency, Mean, Median and (Standard Deviation) of the SNR ratio of the exposure quartiles (N=205)

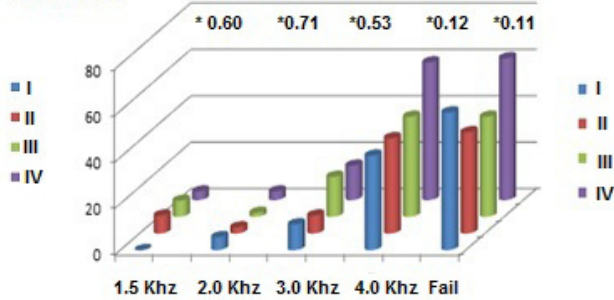
Group**		I	II	III	IV	p value*
<b>TEOAE</b>						
Mean	1.5 kHz	11.5 (5.2)	11.7 (5.5)	11.9 (5.6)	11.1 (4.9)	0.86
	2.0 kHz	12.1 (5.5)	12.3 (5.0)	12.4 (4.5)	10.9 (4.6)	0.78
	3.0 kHz	9.4 (5.1)	9.8 (4.6)	8.8 (5.0)	8.1 (4.4)	0.35
	4.0 kHz	5.2 (4.9)	5.4 (4.5)	4.6 (4.3)	2.9 (3.4)	0.18
Median	1.5 kHz	10.8	11.5	12	11.4	
	2.0 kHz	11.8	12.6	12.8	10.7	
	3.0 kHz	9.3	9	8.5	7.7	
	4.0 kHz	4.3	4.6	4.3	1.9	
<b>DPOAE</b>						
Mean	1.5 kHz	11.1 (8.0)	12.4 (7.8)	11.1 (7.4)	11.9 (7.1)	0.79
	2.0 kHz	11.9 (6.7)	16.6 (6.5)	10.6 (6.6)	10.6 (7.1)	0.47
	3.0 kHz	12.1 (6.9)	11.2 (6.2)	9.8 (6.1)	9.9 (6.6)	0.28
	4.0 kHz	11.3 (7.4)	11.4 (6.1)	10.6 (7.1)	10.8 (6.5)	0.31
	6.0 kHz	12.0 (7.9)	11.6 (8.1)	9.3 (7.6)	8.6 (7.1)	0.09
Median	1.5 kHz	10.4	13.6	10.9	11.5	
	2.0 kHz	11.5	12.7	10.2	9.5	
	3.0 kHz	13	10.9	10.7	10	
	4.0 kHz	11.3	11.25	11.5	9.9	
	6.0 kHz	12.7	12	9.4	7.7	

\*p value obtained by analysis of variance (ANOVA); \*\*Group I is the least exposed group and group IV is the most exposed

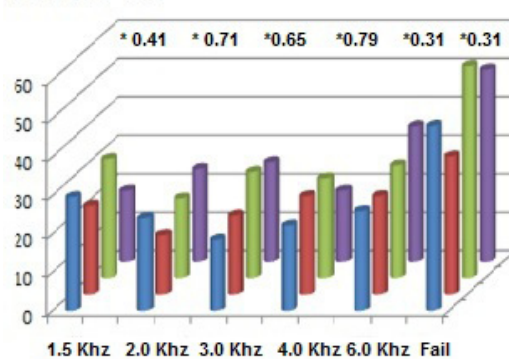
**OD EOAET**



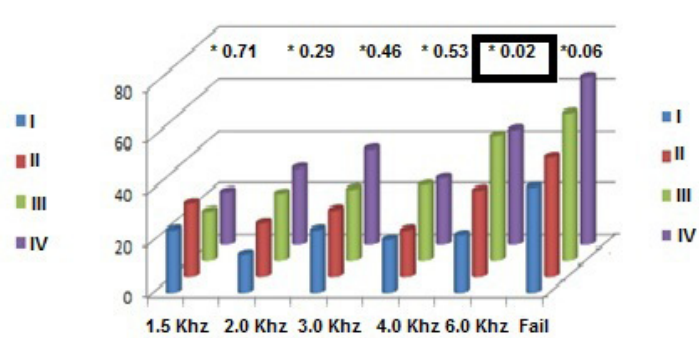
**OE EOAET**



**OD EOAET - PD**



**OE EOAET - PD**



\*p value obtained by way of Pearson's (N>5) and Fisher's (N<5) chi-square tests

**Figure 1.** Frequency of the SNR ratio and the “pass/fail” criteria, subdivided by exposure score and ear, in the total sample (N=205)



“pass/fail” criteria was marginally associated with the degree of exposure ( $p = 0.06$ ).

Table 3 presents the descriptive analysis of the “pass/fail” criteria of the EOAE by exposure quartile, gender and age. Changes in TEOAE responses were associated with the exposure quartile ( $p=0.016$ ) and marginally associated with the participant’s gender ( $p=0.062$ ), being slightly more frequent among males. Changes in TEOAE were not associated with age ( $p=0.181$ ). With respect to DPOAEs, alterations were also associated with pesticide exposure ( $p=0.006$ ), but not with the gender ( $p=0.546$ ) or age ( $p=0.594$ ) of the participant.

Table 4 shows the results of the “pass/fail” criteria of the logistic regression analysis. Quartile I was used as a comparison group for the other quartiles. The chance of the most exposed students (quartile IV) failing the TEOAE test was about 3.5 times higher than among quartile I students (raw OR: 3.44; 95% CI: 1.40-8.44 & adjusted OR: 3.65; 95% CI: 1.35-9.86). The risk estimates were also high for students from groups 2 and 3 when compared to group 1, but without statistical significance. Yet the trend test proved to be significant ( $p=0.029$  for the raw model and  $p=0.035$  for the adjusted model), suggesting that the greater the exposure, the greater the magnitude of risk of alteration in cochlear function. The chance of alteration in cochlear function, assessed by DPOAE, was also significantly higher among students from quartile IV, when compared to those from quartile I. (Raw OR: 2.87; 95% CI: 1.12-7.36 & adjusted OR: 2.61; 95% CI: 1.18-7.15). Again, the statistical test showed an increasing trend of risk with the increase of exposure ( $p=0.051$  for the raw model and  $p=0.043$  for the adjusted model).

## DISCUSSION

Sensory disorder of the vestibulocochlear system may be caused by using ototoxic drugs, exposure to pesticides, exposure to occupational noise and solvents<sup>(17)</sup>, among other factors.

The data obtained in this study suggests that the students from the school in question, in Nova Friburgo, are being exposed to pesticides. A minority is exposed to occupational noise and solvents when handling equipment used in farming.

The young population of Nova Friburgo is actively engaged in agriculture and must have their hearing monitored. A recent study in the United States tested hearing health educational programs for young people performing rural activity, but only assessed the exposure to noise on the farm and during leisure time<sup>(18)</sup>.

Some studies point to the possibility of early detection of hearing loss by examining evoked otoacoustic emissions<sup>(19)</sup>. When responses are present, there is strong evidence of normal or close to normal cochlear function, thus becoming an important tool for objective assessment. The EOAE test can detect changes in outer hair cells even before revealing changes in conventional audiometry<sup>(20)</sup>.

The mean values obtained for the SNR ratio of TEOAE showed a downward trend, with more failures between the frequencies of 2.0 and 4.0 kHz. In the DPOAE test this decrease was more evident in the frequency band of 6 kHz, in the group with the highest exposure score. These results are consistent with studies reporting that high frequencies are the most affected by this type of exposure<sup>(12,21)</sup>.

Similar results were found in analyses of SNR ratio for each separate ear. A higher proportion of failures was observed at the

**Table 3.** Descriptive analysis of the “pass/fail” criteria by exposure quartile, gender and age, (N=205)

	TEOAE				DPOAE				
	Normal	Altered	Total	p value*	Normal	Altered	Total	p value*	
<b>Groups</b>	I	26 (48.1%)	28 (51.9%)	54 (100.0%)	<b>0.016</b>	25 (46.3%)	29 (53.7%)	54 (100.0%)	<b>0.006</b>
	II	17 (43.6%)	22(56.4%)	39 (100.0%)		16 (41.0%)	23 (59.0%)	39 (100.0%)	
	III	24 (41.4%)	34 (58.6%)	58 (100.0%)		12 (20.7%)	46 (79.0%)	58 (100.0%)	
	IV	11 (20.4%)	43 (79.6%)	54 (100.0%)		12 (22.2%)	42 (77.8%)	54 (100.0%)	
<b>Gender</b>	Female	37(37.4%)	62 (62.6%)	99(100.0%)	0.062	24 (24.2%)	75 (75.8%)	99 (100.0%)	0.546
	Male	28 (26.4%)	78 (73.6%)	106 (100.0%)		26 (24.5%)	80 (75.5%)	106 (100.0%)	
<b>Age group</b>	8-19 years	56 (30.4%)	128 (69.6%)	184 (100.0%)	0.181	45 (24.5%)	139 (75.5%)	184 (100.0%)	0.594
	20-30 years	9 (42.9%)	12 (57.1%)	21 (100.0%)		5 (23.8%)	16 (76.2%)	21 (100.0%)	

\*Obtained by way of Pearson’s chi-square test

**Table 4.** Comparison between the results of the “pass/fail” criteria, considering group I as a reference (N = 205)

	TEOAE		DPOAE		
	ORr* (95% CI)	ORa** (95% CI)	ORr* (95% CI)	ORa** (95% CI)	
<b>Groups</b>	I	1	1	1	
	II	1.23(0.52-2.87)	1.27 (0.54-2.98)	1.00(0.42-2.40)	1.02(0.53-2.31)
	III	1.31(0.61-2.81)	1.29 (0.60-2.81)	2.14(0.90-5.08)	2.08(0.89-4.91)
	IV	<b>3.44(1.40-8.44)</b>	<b>3.65 (1.35-9.86)</b>	<b>2.87(1.12-7.36)</b>	<b>2.61(1.18-7.15)</b>
<b>p trend</b>	<b>0.029</b>	<b>0.035</b>	<b>0.051</b>	<b>0.043</b>	

\*Raw odds ratio; \*\*Adjusted odds ratio by gender and age

4-kHz frequency in TEOAE in the most exposed group, both for the right and left ear. For the DPOAE tests, a higher percentage of alteration was also found at the frequency of 6 kHz on both sides. These values can be explained according to the tonotopy of the cochlea. At the base of the cochlea there are short and rigid fibers which are responsive to high frequencies, while at the apex these fibers are long and flexible, responding to the presence of low frequencies<sup>(22)</sup>.

Studies show that ototoxic agents compromise high frequencies before low frequencies, due to the anatomical configuration<sup>(23)</sup>.

Findings in the evoked otoacoustic emissions in individuals with hearing thresholds within the normal criteria are approximately 98%, disagreeing with the findings in this study, where even individuals in the lowest exposure group showed normal responses 48.1% of the time for TEOAE and 46.3% for DPOAE. This fact can probably be explained by the environmental and dietary exposure that affect all residents of that region of Nova Friburgo<sup>(24)</sup>.

Men and women had equal results in alterations of responses for the DPOAE test, and it was not necessary to perform adjusted analysis of the data set. On the other hand, in the TEOAE tests we observed a major alteration in the responses obtained by men, findings that were clear even when adjusted odds ratio analysis was performed. This may be associated with the work done in the field, because men are directly linked to agricultural work, while women are exposed indirectly through their activities in the home, such as washing clothes and equipment used in the field, as well as helping with pesticide application by pulling the hose, and dusting the home<sup>(25)</sup>.

This study found a positive association between exposure to pesticides and alteration in cochlear function, assessed by way of EOAE. The TEOAE test showed a higher sensitivity to detect this association when compared to the DPOAE test, upon performing the specific analysis for each frequency tested. However, the results were similar when considering the altered response at two or more frequencies tested, regardless of the ear.

Some authors conducted a study with 270 male metalworkers, aged between 18 and 30, divided into two groups: GI (160 workers with 1-5 years of exposure) and GII (110 workers with more than 5 years of exposure). For the TEOAE of GI, 82% passed and 5.62% failed on both ears; in GII, 80% passed and 7.3% failed in both ears. For the DPOAE of GI, 96.9% passed and 0.6% failed in both ears. In GII, 97.3% passed and 0.9% failed in both ears<sup>(11)</sup>.

Comparing the results of this study with the aforementioned study, we observe a higher proportion of failures for TEOAE in relation to the DPOAE test, corroborating the statement that the TEOAE examination is an important tool for the early detection of changes in cochlear physiology resulting from occupational exposure both to noise and ototoxic agents.

We suggest that further studies be carried out with students from the region to monitor their hearing health, as many continue to be exposed to pesticides. A longitudinal study could corroborate the association between exposure and cochlear alterations.

## CONCLUSION

The results of this study suggest that exposure to pesticides increases the risk of alterations in cochlear function. In this sense, evoked otoacoustic emissions may help in the early diagnosis of hearing loss when audiometry thresholds have yet to be changed.

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#### Author contributions

*TRG was responsible for data collection and writing of the manuscript; MIKPA was responsible for data collection and study design; SMF did the review of the article; MFM assisted in data collection; RMG performed the statistical analyzes and AM was the general guideline of the research, and responsible for the revision and approval of the final version.*

**Appendix A.** Questionnaire to assess or degree of exposure to pesticides

Questionnaire

I - GENERAL INFORMATION

1. NAME: \_\_\_\_\_  
 2. AGE - day, month and year you were born? day | \_\_ | \_\_ | month | \_\_ | \_\_ | year | \_\_ | \_\_ | \_\_ | \_\_\_\_ | OR \_\_\_\_ years old  
 3. GENDER: ( ) F ( ) M 4. MARITAL STATUS: \_\_\_\_\_  
 5. ADDRESS: \_\_\_\_\_  
 6. NEIGHBORHOOD: \_\_\_\_\_ 7. CITY: \_\_\_\_\_  
 8. ZIP CODE: \_\_\_\_\_ 9. TEL.: \_\_\_\_\_  
 9. Lives on RANCH/FARM/VILLAGE: \_\_\_\_\_

10. EDUCATION:  
 ( ) Illiterate ( ) Completed Primary School II ( ) Completed Secondary School  
 ( ) Completed Primary School I ( ) Did not complete Primary School II ( ) Did not complete Secondary School  
 ( ) Did not complete Primary School I ( ) Did not complete Higher Education ( ) Higher Education degree  
 How many years of schooling? \_\_\_\_\_ (if you can't answer the previous question)

II - INFORMATION ON OCCUPATION AND HABITS

11. OCCUPATION: ( ) farmer ( ) other \_\_\_\_\_  
 12. How long have you worked in this occupation? \_\_\_\_\_ years; \_\_\_\_\_ months; \_\_\_\_\_ days  
 13. Do you work/have you worked in another occupation? ( ) YES ( ) NO WHICH? \_\_\_\_\_  
 FOR HOW LONG ? \_\_\_\_\_ and Do you still work there? ( ) YES ( ) NO  
 \*\* If NON-FARMER, skip to question 17 \*\*  
 14. HOW MANY HOURS do you spend on the farm? | \_\_ | \_\_ | Hours per day  
 15. WHAT CROPS DO YOU GROW on the farm? \_\_\_\_\_

16. The farm you work on is situated at your home? ( ) YES ( ) NO  
 17. What is the DISTANCE from your home to the nearest farm?  
 ( ) less than 50 meters ( ) 100-200 meters  
 ( ) 50-100 meters ( ) more than 200 meters  
 18. When pesticides/insecticides are applied on the crops, can you smell them in your home? ( ) YES ( ) NO  
 19. Do you have a VEGETABLE GARDEN AT HOME? ( ) YES ( ) NO  
 20. Do you CONSUME WHAT YOU PLANT? ( ) YES ( ) NO  
 21. What activities do you do/help with on the farm?

Activities	sometimes	always	never
Weeding			
Digging			
Sowing			
Fertilizing			
Making trenches			
Manuring			
Thinning			
Harvesting			
Preparing poison for application			
Pulling hose for application			
Applying w/ sprayer or hose			
Washing sprayer after application			
Storing the pesticide/poison			

Others: \_\_\_\_\_



### III - HEALTH INFORMATION

22. Have you ever HAD or do you HAVE any HEALTH PROBLEM? ( ) YES ( ) NO  
( ) High blood pressure ( ) High cholesterol ( ) Diabetes ( ) Cancer ( ) AIDS  
( ) Neurological Disorder ( ) Eyes ( ) Skin ( ) Lungs ( ) Intestine  
( ) Head ( ) Liver ( ) Others \_\_\_\_\_
25. Do you take any medicine? ( ) YES ( ) NO WHI  
CH? \_\_\_\_\_

### IV - HEARING INFORMATION

26. Do you have ANY HEARING LOSS? ( ) YES ( ) NO  
27. Have you noticed any LIQUID coming out of your ear (otorrhea)? ( ) YES ( ) NO  
28. Have you had any ear SURGERY? ( ) YES ( ) NO  
29. Have you ever had a perforated eardrum? ( ) YES ( ) NO  
30. Have you ever been exposed to loud noise at work? ( ) YES ( ) NO  
WHAT NOISE? \_\_\_\_\_ For how long? \_\_\_\_\_  
31. Do you think you HEAR WELL in SILENT environments? ( ) YES ( ) NO  
32. Do you think you HEAR WELL in NOISY environments? ( ) YES ( ) NO  
33. Do you have tinnitus? ( ) YES ( ) NO

### V - INFORMATION ON PESTICIDE USE

3. Which POISON do you USE in your WORK?  
( ) Actara (insecticide/neonicotinoid) ( ) Curzate Br (fungicide/dimethyldithiocarbamate)  
( ) Decis (insecticide/pyrethroid) ( ) Fastac (insecticide/pyrethroid)  
( ) Glifosato (herbicide/glyphosate) ( ) Gramoxone (herbicide/paraquat)  
( ) Lannate (insecticide/methylcarbamate) ( ) Polytrin (insecticide/organophosphate)  
( ) Premio (insecticide/anthranilamide) ( ) Roundup (herbicide/glyphosate)  
( ) Tamaron (acaricide insecticide/organophosphate) ( ) Tordon (herbicide/picloram)  
( ) Turbo (insecticid/ pyrethroid) ( ) Vertimec (acaricide, nematocide, insecticide/avermectin)  
( ) Others \_\_\_\_\_
35. HOW LONG have you WORKED WITH POISON IN PLANTING?  
( ) less than 1 year ( ) 11-20 years  
( ) 1-5 years ( ) 21-30 years  
( ) 5-10 years ( ) over 30 years
36. WHAT CONTACT DO YOU HAVE WITH PESTICIDES/POISON?  
( ) direct (handling the mixture and applying on the farm)  
( ) direct (pulling the hose during spraying)  
( ) indirect (the farm is situated at home)  
( ) indirect (washing the sprayer)
37. During the LAST SEASON, HOW MANY DAYS did you APPLY POISON?  
( ) Never  
( ) 1-5 days  
( ) 6-25 days  
( ) 26-50 days  
( ) Over 50 days
38. How many liters and/or kilograms do you use per week/month? \_\_\_\_\_
39. HOW MANY TIMES PER MONTH DO YOU USE THE POISON?  
( ) once ( ) 5-10 times  
( ) 1-5 times ( ) over 10 times
40. HOW OLD were you when you FIRST came into CONTACT with PESTICIDE?  
( ) 5-10 years old ( ) 15-20 years old  
( ) 10-15 years old ( ) over 21 years old
41. HOW OFTEN DO YOU PERFORM THESE ACTIVITIES?

41.1. EXPOSURE TO NOISE (very loud noise) - Driving trucks, tractors and buses, grinding food, or welding?

- Never, or less than once per month
- 1-3 times per month (monthly)
- 1-5 times per week (weekly)
- 6-7 times per week (daily)

41.2. DO YOU HANDLE GASOLINE OR ANY CLEANING SOLVENT?

- Never, or less than once per month
- 1-3 times per month (monthly)
- 1-5 times per week (weekly)
- 6-7 times per week (daily)

41.3. PAINTING

- Never, or less than once per month
- 1-3 times per month (monthly)
- 1-5 times per week (weekly)
- 6-7 times per week (daily)

VI - WORK HABITS

42. HOW MANY HOURS do you WORK per day?

- 4 hours             10 hours
- 6 hours             12 hours
- 8 hours             over 12 hours

43. How OFTEN do you USE PERSONAL PROTECTIVE EQUIPMENT (PPE) when in contact with PESTICIDE?

- always             sometimes             never.

IF NOT, WHY DO YOU NOT USE PPE OFTEN?

- I don't need it             it's disruptive             it makes the job harder
- it is uncomfortable             I don't have any             other \_\_\_\_\_

IF YOU DO USE PPE, ANSWER THE QUESTIONS BELOW:

WHAT PPE DO YOU USE?

- Paper mask             Cloth mask             Respirator             Boots
- Disposable clothing             rubber gloves             Wool gloves             glasses
- Overalls             Apron             Other \_\_\_\_\_

44. HOW LONG HAVE YOU USED PPE?

- less than one year             over 10 years
- 1-5 years             I've always used PPE
- 5- 10 years

45. Types of CLOTHING you use when APPLYING PESTICIDE or PULLING THE HOSE:

On your feet	<input type="checkbox"/> Open shoes	<input type="checkbox"/> closed shoes	
Torso	<input type="checkbox"/> no shirt	<input type="checkbox"/> short sleeve or sleeveless	<input type="checkbox"/> long sleeve
Legs	<input type="checkbox"/> shorts	<input type="checkbox"/> long pants	

46. For how many days do you wear the same clothes for the preparation and application of poison? \_\_\_ days

- 47. Do you wash your hands during or after work?             YES             NO
- 48. Do you shower immediately after applying pesticides/poisons?             YES             NO
- 49. Do you usually eat during the application of pesticides?             YES             NO
- 50. How often do you wash the clothes used in the application of poisons on crops?  
 immediately after the application of pesticides             the following day
- 51. Do you wash the clothes used on the farm?             YES             NO

Scoring key

Variable	Answers	Score
Hours worked per day	0-1 hour	0 points
	1-4 hours	1 point
	5-8 hours	2 points
	8 hours or more	3 points

Farm at home	No	0 points
	Yes	1 point
Distance from home to farm	Less than 50 meters	3 points
	50-100 meters	2 points
	100-200 meters	1 point
	More than 200 meters	0 points
Exposure time	Never	0 points
	1-5 years	1 point
	5-20 years	2 points
	21-30 years	3 points
Days of use during the last season	Never	0 points
	1-5 days	1 point
	6-25 days	2 points
	26-50 days	3 points
	Over 50 days	4 points
Amount of use per month	Never	0 points
	1-5 times	1 point
	6-30 times	2 points
	Over 50 times	3 points
Age of first contact with pesticides	18 or over	0 points
	10-17 years old	1 point
	05-10 years old	2 points
Contact with pesticides	handling the mixture and applying on the farm	4 points
	pulling the hose during spraying	3 points
	the farm is situated at home	2 points
	washing the sprayer	1 point

		Always	Sometimes	Never
Activities performed on the farm	Weeding	1 point	1 point	0 points
	Digging	1 point	1 point	0 points
	Sowing	1 point	1 point	0 points
	Fertilizing	1 point	1 point	0 points
	Making trenches	1 point	1 point	0 points
	Manuring	1 point	1 point	0 points
	Thinning	1 point	1 point	0 points
	Harvesting	1 point	1 point	0 points
	Preparing poison for application	1 point	1 point	0 points
	Pulling hose for application	9 points	8 points	0 points
	Applying w/ sprayer or hose	9 points	9 points	0 points
	Washing sprayer after application	8 points	8 points	0 points
	Storing the pesticide/poison	9 points	9 points	0 points