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The influence of amplified music on the auditory profile of high school students

A influência da música amplificada no perfil auditivo de estudantes de ensino médio

La influencia de la música amplificada en el perfil auditivo de estudiantes de secundaria

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Abstract

Objective: To verify the auditory profile of high school students, users of amplified music in personal listening devices. **Methods:** A questionnaire and information about hearing health was applied, and the audiological evaluation was performed composed of pure tone audiometry, immitanciometry and otoacoustic emissions evoked by distortion product. **Results:** The mean age of the 19 high school students participants was 16.36 years. Everyone makes use of headset. 31.6% use the headset for 1 to 3 years and 42.1% use it for 1 to 3 hours a day. 52.6% of them use 51 to 75% of the appliance's power and 42,1% classify the sound they hear as loud. The averages of hearing thresholds of the airway presented themselves within normality, however there was a slight decrease in the frequency of 6000 Hz in relation to the frequency of 4000 Hz and 8000 Hz, in both ears. Subjects with tinnitus presented lower sign/noise averages of otoacoustic emission in pratically all frequencies, occurring statistically significant difference on the frequency of 5000 Hz on the right ear. **Conclusions:** Signals were observed indicating possible changes in high frequencies that are commonly affected by exposure to noise and amplified music. While

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Authors' contributions:
DSO and MZ: Concept of the study; Methodology; Data collection; Article outline.
LSQ: Concept of the study; Methodology; Data collection; Article outline; Orientation.
LD: Critical Review.

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acknowledging that they hear loud music, and knowing it harms hearing, most individuals in this study are not aware that the change caused by amplified music is irreversible.

Keywords: Hearing; Students; Music; Hearing Loss.

Resumo

Objetivo: Verificar o perfil auditivo de estudantes de Ensino Médio, usuários de música amplificada em dispositivos de escuta pessoal. Método: Foi aplicado questionário e concedidas informações sobre saúde auditiva, sendo realizada a avaliação audiológica composta por Audiometria Tonal Liminar, Imitanciometria e Emissões Otoacústicas Evocadas por Produto de Distorção. Resultados: A média de faixa etária dos 19 estudantes de Ensino Médio participantes foi 16,36 anos. Todos fazem uso de fone de ouvido, 31,6% usam o fone de ouvido de 1 a 3 anos e 42,1% utilizam-no de 1 a 3 horas por dia, 52,6% dos sujeitos fazem uso de 51 a 75% da potência do aparelho e 42,1% classificam o som que ouvem como alto. As médias de limiares auditivos de via aérea apresentaram-se dentro da normalidade, porém, observou-se leve rebaixamento na frequência de 6000 Hz em relação à frequência de 4000 Hz e 8000 Hz, em ambas as orelhas. Indivíduos com zumbido apresentaram as médias de sinal/ruído de emissões otoacústicas inferiores em praticamente todas as frequências, ocorrendo diferença estatisticamente significante na frequência de 5000 Hz na orelha direita. Conclusões: Observaram-se sinais indicativos de possíveis alterações em frequências altas, que são comumente afetadas pela exposição ao ruído e música amplificada. Mesmo reconhecendo que ouvem música alta e sabendo que a mesma prejudica a audição, grande parte dos indivíduos deste estudo não está ciente de que a alteração causada pela música amplificada é irreversível.

Palavras-chave: Audição; Estudantes; Música; Perda Auditiva.

Resumen

Objetivo: Verificar el perfil auditivo de estudiantes de enseñanza media, usuarios de música amplificada en dispositivos de escucha personal. **Método:** Fue aplicado cuestionario y concedidas informaciones acerca de la salud auditiva, siendo realizada la evaluación audiológica compuesta por Audiometría Tonal Liminar, Imitanciometría y Emisiones Otoacústicas Evocadas por Producto de Distorsion. **Resultados:** El promedio de edad de los 19 estudiantes de enseñanza media participantes fue 16,36 años. Todos usan los auriculares, 31,6% los usan de 1 a 3 años y 42,1% los utilizan de 1 a 3 horas por día, 52,6% de los sujetos hacen uso de 51% a 75% de la potencia del aparato y 42,1% clasifica el sonido que oye como alto. Los pormedios de umbrales auditivos de la vía aérea se presentaron dentro de la normalidad; sin embargo, se observó leve descenso en la frecuencia de 6000 Hz en relación a la frecuencias de 4000 Hz y 8000 Hz en ambas las orejas. Individuos con zumbido presentaron los promedios de señal/ruido de emisiones otoacústicas inferiores en prácticamente todas las frecuencias, ocurriendo diferencia estadísticamente significativa en la frecuencia de 5000 Hz en la oreja derecha. **Conclusiones:** Se observaron señales indicativos de posibles alteraciones en frecuencias altas, que son comúnmente afectadas por la exposición al ruido y la música amplificada. Aún reconociendo que oyen música alta y sabiendo que perjudica a la audición, gran parte de los indivíduos del estudio no tiene conciencia que la alteración causada por la música amplificada es irreversible.

Palabras claves: Audición; Estudiantes; Música; Pérdida Auditiva.

Introduction

Hearing is one of the most important senses, once its functionality was fundamental base for the construction of human communication[1]. Since birth, hearing has set the relation between men and their fellow human beings[2].

The sound, being unpleasant or pleasurable, is present in all moments of the life[3]. However, when hearing structures are altered or impaired, a reduction in hearing capacity occurres[2]. Noise is a factor, which according to its exposure time and when too high, can damage the hearing system[4].

The Noise-Induced Hearing Loss (NIHL) is a neurosensory loss irreversible and progressive, acquired by the exposure to the noise[4]. If this exposure is continuous, the temporary alterations in the cochlea cells can become a permanent damage impairment[5].

Usually, there is concern only with the exposure to noise in places of work and it isn't noticed that in other situations there is also an exposure to noise that is detrimental[5]. Although not being considered a noise, but a pleasant sound, music when played in a high intensity, can become a threat to the human ear[6].

Sounds superior to 75 Decibels (dB) are considered detrimental to the auditory system; however, most of the sound portable devices can hit 130 dBs[7]. It was observed, that after 15 minutes of intense exposure of 110 dBNA in an Mp3 Player signs of temporary alterations in the cochlea cells already occur[5]. However, the earplugs are commonly used with no concerns regarding the level or duration of the exposure[8].

According to the World Health Organization, more than 5% of the world population has hearing loss and 1,1 billion of young people are at risk to have it as a consequence of the exposure to noise in recreational environments[9]. Thus, this research aims to verify the hearing profile of High School students, users of amplified music in personal listening devices.

Method

The present study was authorized by the Research and Ethics Comitte of the University of Passo Fundo (UPF) under the registered number 1.755.107. The data collection started after the consent of the direction of a State School in Passo Fundo, where 236 High School students were invited to participate in the study; from these 86 were interested, however, only 28 appeared for the audiological evaluation. Out of these 28 subjects, nine were excluded for not meeting the inclusion criteria.

Were considered inclusion criterias: being student in High School, not presenting a history of hearing pathology or exposure to ocupational noise, present timpanometric curve type A and accepting the Written Informed Consent (WIC). Therefore, this study was composed by one group of 19 High School students, from the city of Passo Fundo, 8 male subjects and 11 female, with average age between 15 and 19 years old.

The students, after receiving an explanatory flyer and orientation about hearing health, were invited to answer a questionnaire and to appear in the Speech Lacnguage Pathology and Audiology (SLPA) Clínic at UPF to have a hearing evaluation. The use of the questionnaire "Analysis of the Knowledge Level of Young People About the Risks of Amplified Music in Hearing Health" developed by Snat'Ana, N.C. and Lopes, A.C. (2009)[10], consisting in 19 objective questions regarding to the hearing habits, speacially exposure to amplified music, hearing characteristics and knowledge about hearing health. In terms of the questionnaire analysis only some questions were highlighted, for being more relevant to this study.

The audiology evaluation was composed by a pure tone audiometry (PTA), immitancionetry and Evoked Otoacustics Emissions by Distortion Product (EOEDP). Before the audiology exam a short hearing anamnesis to confirm some inclusion criterias and a meatoscopy.

Audiometry was performed in an appropriate acustic room, inside the SLPA Clinic at UPF, with the Diagnostic Audiometer AD 229e, Interacustic brand, properly measured and calibrated according to the norm ISO 8253-1. It was investigated, by air conductions, the frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000 e 8000 Hertz (Hz).

In the classification of the hearing loss it was followed the criterias proposed by the Ordinance nº 19 (Secretariat of Health and Safety at Work). It was considered acceptable levels the subjects which audiograms showed the Auditory Threshold Tones lower or equal to 25 dB Audible Level (AL) in all

the frequencies analized and classified as normal threshold[11].

The imitanciometry exam was performed in the Impedance Audiometer AZ26 immitanciometer, Interacustic brand, being carried out the timpanometry and the contralateral and ipsilateral acustic reflexes. The contralateral reflexes were classified as present and normal when the difference between the reflex threshold and the PTA threshold in this same frequency was 70 to 90 dB, exacerbated when the difference was higher than 90 dB, and absent when not triggered until the maximum out of the equipment.

The EOEDP research in the frequencies 2000, 3000, 4000 and 5000 Hz was performed in the Otoread Interacoustic equipment, and aimed to verify the integrity of the inner ear. Considering PASS, when the relation signal/noise (S/N) presented results igual or higher than 6 dB, in at least three frequencies, in any ear. Each result of the EOEDP was printed to be able to analyze the results in the relation S/N in each evaluated frequency.

For the statistical analysis of the obtained results, it was used the *Student* t-Test to analyze the intensities of the contralateral acoustic reflexes in normal and exarcebated levels, as well as to the average analysis S/N of EOEDPs of subjects with or without tinnitus, having as base and significance level $p<0,05$.

Results

Nineteen High School students participated in this research, 8 male and 11 female, with average age of 16,36 years old.

It was observed, that all the 19 (100%) subjects that participated in the research make use of headphones, and 10 (52,6%) of these make frequent use of it. (Figure 1).

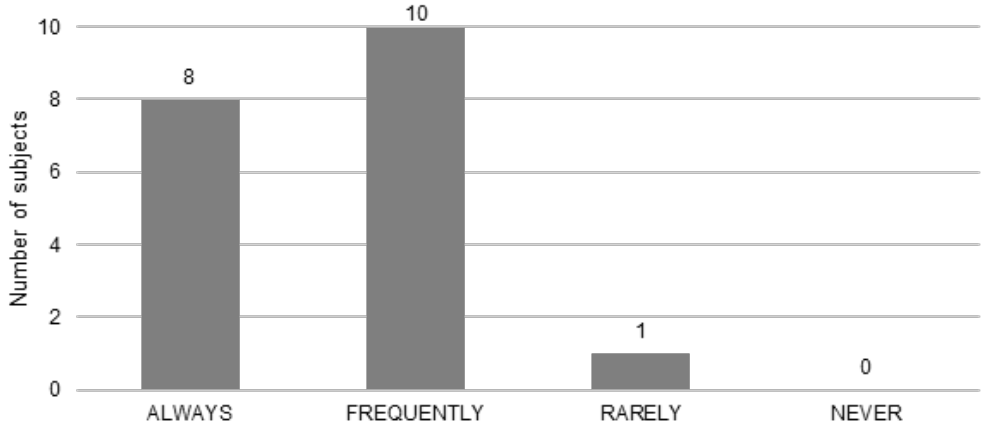

Figure 1. Frequency of headphone usage.

Considering the time of use of the headphone, it was pointed out that 6 subjects (31,6%) are making use of it from 1 to 3 years, and it was observed that the majority, 8 of the subjects (42,1%), use it from 1 to 3 hours per day, every day (Figure 2).

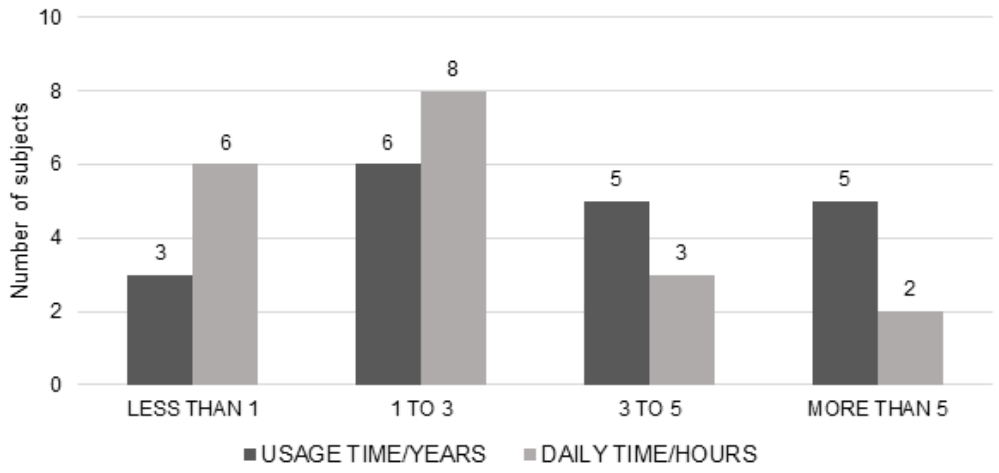

Figure 2. Time of headphone usage in years and in daily use.

Regarding the use of the headphones and the intensity of the volume, 10 subjects (52,6%), make use of 51 to 75% of the device power (Figure 3).

Regarding the classification of the sound they hear, 8 subjects (42,1%), classify this sound as high, but 8 (42,1%) declared it as comfortable (Figure 4).

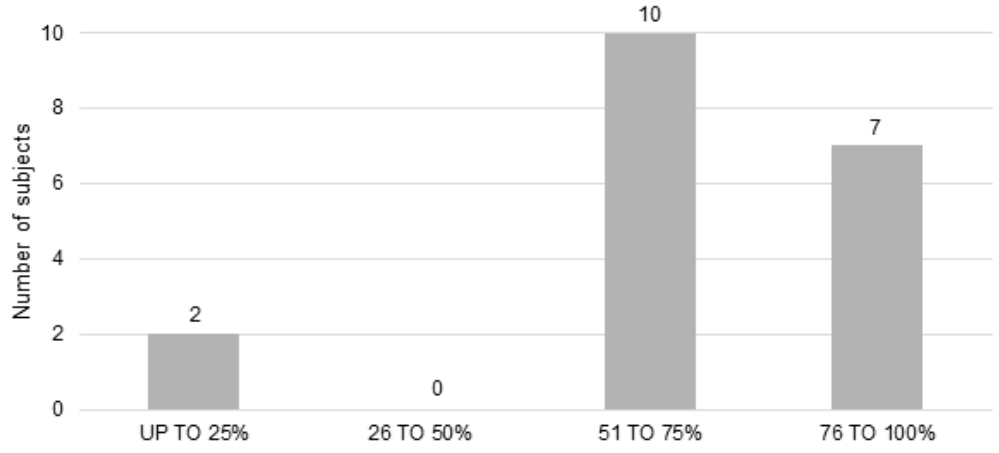

Figure 3. Device volume usage.

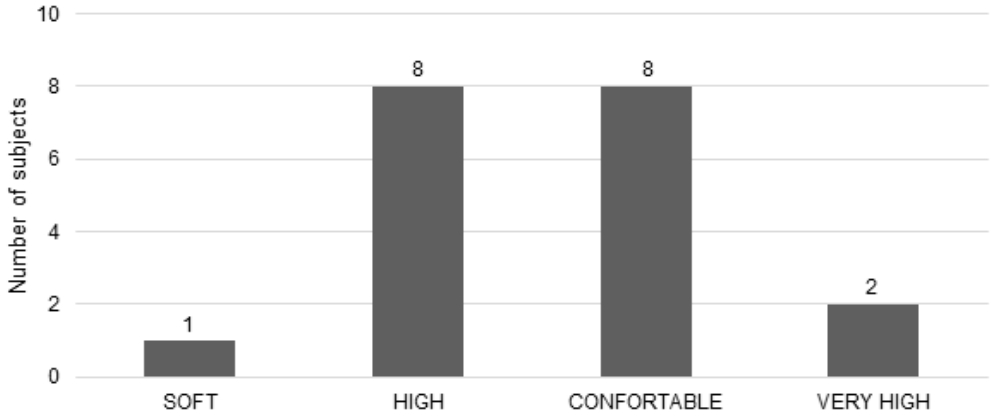

Figure 4. Classification of the sound they hear.

In the questions referring to the subjects knowledge, in relation to hearing and impairment caused by the headphone, it was noticed that the majority of the subjects, 17 (89,5%), believed that the amplified music is harmful to the hearing, but just 5 (26,3%) believed that their hearing is impaired.

When questioned if they received information about the hearing being affected by amplified music, all of the participants stated yes. However, 11 subjects (57,9%) believed that hearing loss has a cure (Figure 5).

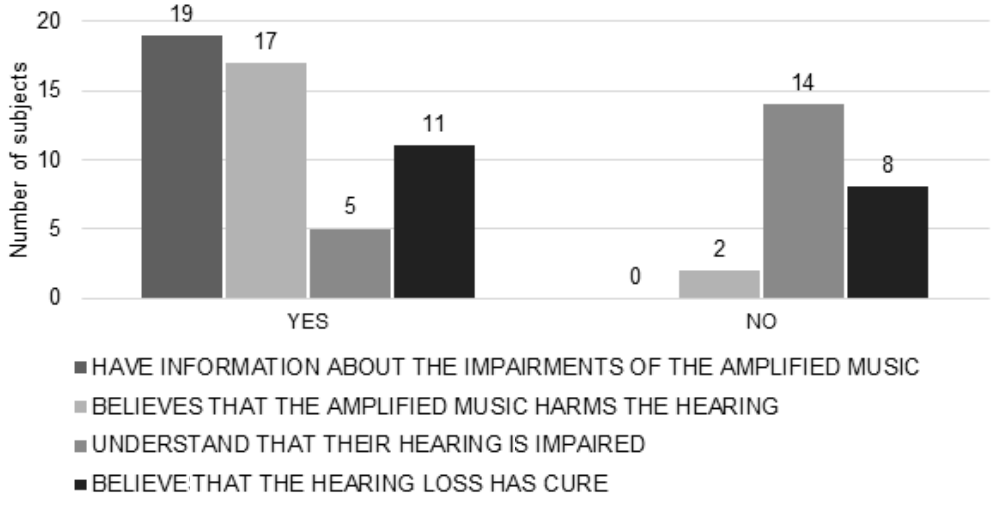

Figure 5. Information about hearing and impairments caused by headphones.

Auditory complaints were reported by the subjects, where 10 of the research individuals (52,6%) say they have tinnitus, and 2 of them report tinnitus only in their right ear (Figure 6).

In Figure 7, the average of hearing threshold of air conduction by ear and by frequency is within the normality. Although, it was observed a slight decrease in the 6000 Hz frequency compared to the 4000 Hz and 8000 Hz frequencies, in both ears.

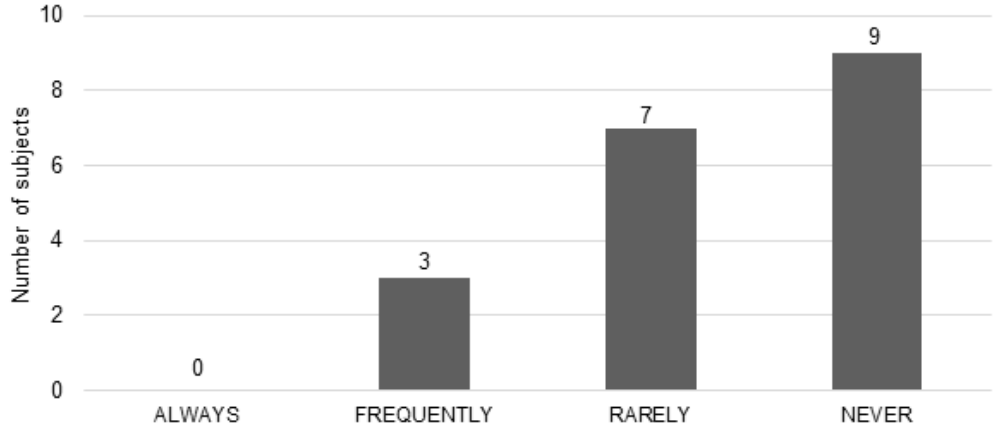

Figure 6. Tinnitus presence.

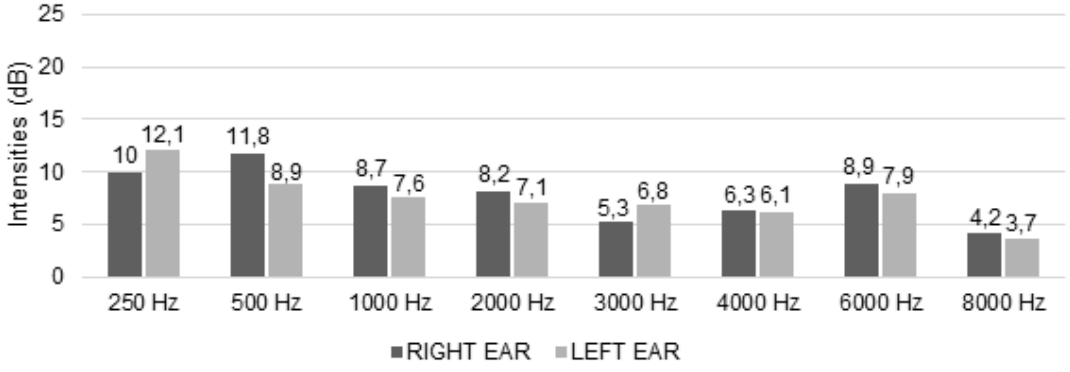

Figure 7. Average hearing threshold airway by frequency and by ear.

In the analysis of the contralateral acoustic reflexes, the ones in a normal intensity stand out in all frequencies in the right ear. In the left ear the same can be observed, yet only in the 2000 Hz frequency, demonstrating a higher number of subjects with the reflexes present, but in exacerbated levels. It is noticed, though, that regarding the contralateral acoustic reflexes that are absent, its occurrence is higher in the frequency 4000 Hz comparing to the other frequencies, in both ears.

Throughout the *t Student* Test it was observed an association between the intensities (threshold) in the reflexes in normal and exacerbated levels, having a statistically significant difference on the frequencies of 500, 2000 and 4000 Hz to the right, and only on the 2000 Hz frequency to the left (Table 1).

Table 1. Contralateral Acoustic Reflexes by frequency and by ear.

Frequency (Hz)		Absent	Normal	Exacerbated	p - Value
RIGHT EAR					
500	Mean		94.91	108.4	0.0001*
	Standard Deviation		4.13	3.58	
	Number of Individuals	3	11	5	
1000	Mean		96.2	101.5	0.1174
	Standard Deviation		5.77	7.84	
	Number of Individuals	1	10	8	
2000	Mean		90.45	100.67	0.0050*
	Standard Deviation		6.62	5.01	
	Number of Individuals	2	11	6	
4000	Mean		90.13	104.5	0.0004*
	Standard Deviation		3.4	6.4	
	Number of Individuals	7	8	4	
LEFT EAR					
500	Mean		98.86	103.09	0.1883
	Standard Deviation		7.1	5.89	
	Number of Individuals	1	7	11	
1000	Mean		94.11	100.22	0.0543
	Standard Deviation		4.37	7.64	
	Number of Individuals	1	9	9	
2000	Mean		91.8	101	0.0072*
	Standard Deviation		5.2	7.48	
	Number of Individuals	1	10	8	
4000	Mean		93,71	100.38	0,0929
	Standard Deviation		6,97	7,21	
	Number of Individuals	4	7	8	

*Values statistically significant (p<0,05) – *t Student* Test.

In the data regarding to the EOEDP the results of only 16 out of the 19 subjects are exposed, since, because of the problems in the otoacoustic emissions equipment, the evaluations of 3 subjects needed to be discarded in order to not compromise the results of the study.

It was observed that the average of the values of the S/N relation presented itself lower in the frequencies on the left ear, being that the lowest average is on the 2000 Hz frequency on the left and 4000 Hz on the right (Figure 8). All the subjects showed presence in the EOEDP in both ears, althoug, it was verified that three subjects presented intensity of S/N lower than 6 dB in the left ear, one in the 2000 Hz frequency and two in the 5000 Hz to the left.

When analyzed the average of the S/N of the EOEDP in individuals with or without tinnitus, it was observed that the subjects with tinnitus presented lower average in almost all the frequencies, occurring statistically significant difference in the 5000 Hz frequency on the right ear (Table 2).

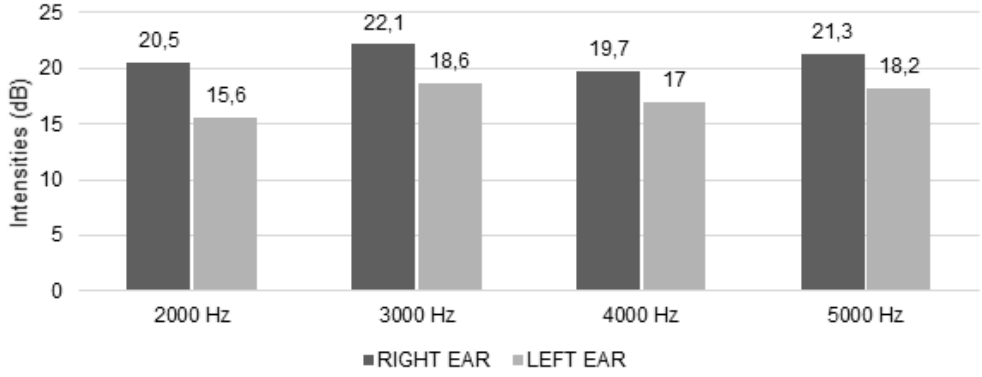

Figure 8. Average of the S/N value relation on the Evoked Otoacustics Emissions by Distortion Product by frequency and by ear.

Table 2. Signal/noise relation of the Evoked Otoacustics Emissions by Distortion Product in individuals with and without tinntus by ear and by frequency.

Ear	Frequency (Hz)	Average (dB)		p - Value
		With Tinnitus	Without Tinnitus	
Right	2000	19.0	22.4	0.256
	3000	21.0	23.4	0.347
	4000	19.2	20.3	0.738
	5000	17.2	26.4	0.029*
Left	2000	15.0	16.3	0.754
	3000	18.8	18.3	0.87
	4000	15.1	19.4	0.227
	5000	16.0	21.0	0.265

*Values statistically significant (p<0,05) – *t Student* Test.

Discussion

The use of personal stereo devices by young people is very common. Since they are practical and portable they are becoming essential accessories to the daily life[12]. The frequent use of the devices that reproduce music by the population is due to the evolution of technology, allied to the capacity of this small electronic devices store files[7].

The results of this study presented a reduced number of subjects in comparison to the number of students that were the invited to participate. This is a sign of the lack of interest of the High School students for their hearing health.

The same was found in a study that invited students from an Elementary and High School to participate in educational lectures about hearing health, and resulted in part of the students of the High School abandoning the lecture place and not returning the WIC signed by their guardians. Even though they received a larger number of invitations, they became the minority in the study[13].

It was observed, in the present research, that all the individuals participating were headphone users. Confirming the findings in the literature, that show that many recent studies have been noticing a large prevalence of individuals that use personal stereos[12, 13, 14, 15, 16, 17, 18].

In relation to the time of use of headphones, the results in this study showed that the majority of the subjects have been using headphones for a period of one to three years. This is in compliance with the study that evaluated teenagers of 12 to 17 years old, MP3 Players users, and verified that the prevalence of the time of use was lower than three years[15]. However, other researchers observed users of headphones that have been using it for a longer period of time[14, 19, 20].

Regarding the daily use, it was observed that the prevalence is of one to three hours. This result corroborates to authors that observed that great part of the individuals use headphones in an average of one to three hours a day[15, 19, 20]. Although other researchers found users that reported making use of headphones for more than three hours a day[12, 13, 14].

The time of exposure and quantity of noise are factors that impair the hearing[7]. Nonetheless, it was observed in this study that the subjects were not concerned, according to the data referring to the intensity usually used, since the most part of the subjects uses around 51 to 75% of the device potency, and 42,1% of the individuals classify the sound they hear as high. Similarly, researches show that the majority of the users report to listen to music in a high intensity[12, 17], a lot of which use it in maximum volume[16, 21] or exceed the threshold considered safe[22, 23].

One of the main factors that damage hearing of subjects that listen to amplified music on their headphones is the intensity. In this regard, a study that evaluated the level of intensity of the sound that users of MP3 reproduction devices submit themselves, observed that the average of the sound for 75% of the volume is 96.8 dB (A) with peaks of 106.2 dB (A), and, with 100% of the volume, the average is 109.4 dB (A) with peaks of 120.7 dB (A)[3]. It is known, that the exposure higher than 75 to 90 dB can cause mechanical alterations and metabolic alterations in the cochlear and vascular structures, and in the Corti organ, where the most damaged are the outer hair cells[7].

Regarding the individuals knowledge in relation to the hearing and the damages caused by headphone, it was verified that most of the participating subjects believe that the amplified music is harmful to the hearing. This is similar to other studies where the users considered that bad hearing habits can cause hearing problems[12,14].

Studies confirmed that the majority of the users are informed about the impairments that bad hearing habits can bring to hearing health[12, 13, 14]. Fact found in the results of this study, since when questioned if they received information about hearing being harmed by amplified music, all of the participants of this study affirmed yes. However, when asked about hearing impairment, a large amount of the subjects stated believing that this has cure. Similar results were found in a study that used the same questionnaire[14].

A number of studies showed tinnitus as a very common symptom in users of personal stereos[12, 13, 14, 15, 17, 24, 25, 26]. This corroborates with the present research in which the presence of tinnitus was detected in more than 50% of the subjects' sample.

The literature states that high frequencies (around 4000 and 6000 Hz) are related to the hearing loss due to intense noise[7]. Therefore, as the auditory threshold was analyzed in users of personal stereo, it was found indicative risks for hearing loss induced by noise, even in normal hearing[14,19]. In this study the average of auditory threshold in

air conduction by frequencies and by ear presented within the normality, but it was observed a slight decrease in the 6000 Hz frequency compared to the 4000 Hz and 8000 Hz frequencies, in both ears, suggesting a possible beginning of hearing alteration caused by the loud music.

Throughout the *t Student* Test it was observed in this research, statistically significant difference for contralateral acoustic reflexes on the frequencies 500, 2000 and 4000 Hz to the right, and 2000 Hz to the left, showing that even with the use of amplified music, the protection of the inner ear, through the acoustic reflex, keeps itself present and efficient. However, a study that compared evaluations of users and non-users of the personal listening devices found thresholds of acoustic reflexes superior in participants that used the device, when compared to non-users[20].

In the data regarding to the EOEDP of this research, all the subjects showed presence in both ears. However, studies have shown that users of the personal listening device presented results of the S/N[20] and amplitude[19] of the otoacoustic emissions inferior to the non-users.

When comparing the average of the S/N of the EOEDP in indivuduals with or without tinnitus, it was observed that the subjects with tinnitus presented lower average in almost all the frequencies, occurring statistically significant difference in the 5000 Hz frequency on the right ear. This significantly result can be explained in the sense that literature mentioned tinnintus as an alert symptom of impairment in the periferic hearing, before the perception of the hearing loss[26], being that it can be generated by any and all factors that cause alterations in the function of the auditory system[27].

The acoustic trauma is one of the most common causes, and if the exposure is excessive and continuos it can occasionate alterations that would cause permanent tinnitus and hearing loss[27]. Moreover, the outter hair cells are vulnerable to the external factors such as noise, allowing the otoacustic emissions to be used for detecting the inicial signs of cochlear alterations[28], being the EOEDP efficient to capture answers in the high frequencies, the same ones inicially impaired by the NIHL[29]. For this reason, it is emphasized the importance of the EOEDP for earlier diagnosis of NIHL[29], because before it alters in the audiogram the cochlear disfunction alters the results of the otoacustic emissions[28].

Conclusion

The hearing profile of the participants in this study presented the hearing threshold by airway and EOEDP compatible with the normality standards. However, it was observed a slight decrease in the 6000 Hz frequency compared to the 4000 Hz and 8000 Hz frequencies, in both ears; also, statistically significant difference between the average of S/N and EOEDP in individuals with or without tinnitus on the 5000 Hz frequency in the right ear, frequencies near to the ones that are usually affected by the intense noise.

In the long term, these are subjects susceptible to develop earlier hearing alterations, once, these are indicative signals of possible alterations in high frequency, the same that are commonly affected by the exposure to noise and amplified music. Even though they recognize that they listen to loud music and knowing that this is harmful to their hearing, great part of the individuals participating on this study are not aware that the alterations caused by the amplified music are irreversible.

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