

# Characteristics of the tinnitus and hyperacusis in normal hearing individuals

## Características do zumbido e da hiperacusia em indivíduos normo-ouvintes

Daila Urnau<sup>1</sup>, Tania Maria Tochetto<sup>2</sup>.

1) Post graduate. Speech Therapist.

2) Doctor in Science of Human Communication Disorders. Professor Associate to the Department of Phonoaudiology of UFSM, Santa Maria (RS), Brazil.

Institution: Federal University of Santa Maria.

Santa Maria / RS - Brazil

Mailling address: Street Lava Pés, 878 - Apartment 103 - Downtown - Passo Fundo / RS - Brazil - ZIP code: 99010-170 Telephone: (+5554) 91355594 - E-mail:

daila\_urnau@yahoo.com.br

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### SUMMARY

**Introduction:** The tinnitus has become a common otological complaint. Another complaint is found in bearers of the tinnitus is the hyperacusis.

**Objective:** Analyze the characteristics of tinnitus and hyperacusis in normal hearing individuals with associated complaints of tinnitus and hyperacusis.

**Method:** 25 normal hearing individuals who complained of hyperacusis and tinnitus were surveyed in this form of cross-sectional study. They were questioned about the location and type of the tinnitus. The evaluation of the tinnitus was made using the Brazilian Tinnitus Handicap Inventory and acuphenometry. A questionnaire was made about the hyperacusis covering aspects such as: sounds considered uncomfortable, sensations in the presence of such sounds, and difficulty understanding speech in noise.

**Results:** Of the 25 individuals, 64% were women and 36% men. Regarding tinnitus, 84% referred to bilateral location and 80% high pitch. The most common degree found was light (44%). The women presented tinnitus degree statistically superior to those of men. The strong intensity sounds and the reactions of irritation, anxiety and the need to move away from the sound were the most mentioned. From the analyzed individuals, 68% referred to difficulty understanding speech in noise and 12% reported using hearing protection. The most found frequencies at the acuphenometry were 6 and 8 KHz.

**Conclusion:** Normal hearing individuals who complain of tinnitus and hyperacusis present mainly high pitch tinnitus, located bilaterally and light degree. The sounds considered uncomfortable were the high intensity ones and the most cited reaction to sound was irritation. The difficulty to understand speech in noise was reported by most of the individuals.

**Keywords:** hearing, tinnitus, hyperacusis, questionnaires.

### RESUMO

**Introdução:** O zumbido vem se tornando uma queixa otológica frequente. Outra queixa que é encontrada em portadores de zumbido é a hiperacusia.

**Objetivo:** Analisar as características do zumbido e da hiperacusia em indivíduos normo-ouvintes com queixa associada de zumbido e hiperacusia.

**Método:** 25 indivíduos normo-ouvintes que apresentaram queixas de hiperacusia e zumbido foram pesquisados nesta forma de estudo transversal. Questionou-se sobre a localização e o tipo do zumbido. Utilizou-se o Tinnitus Handicap Inventory brasileiro e a acufenometria para avaliação do zumbido. Foi elaborado um questionário sobre hiperacusia abordando aspectos como: sons considerados desconfortáveis, sensações na presença desses sons e dificuldade de compreensão de fala no ruído.

**Resultados:** Dos 25 indivíduos, 64% eram mulheres e 36% homens. Em relação ao zumbido, 84% referiram localização bilateral e 80% pitch agudo. O grau mais encontrado foi o leve (44%). As mulheres apresentaram grau de zumbido estatisticamente superior ao dos homens. Os sons de forte intensidade e as reações de irritação, ansiedade, necessidade de afastar-se do som foram mais citadas. Dos indivíduos analisados, 68% referiram dificuldade de compreensão de fala no ruído e 12% relataram usar protetores auriculares. As frequências mais encontradas na acufenometria foram 6 e 8 KHz.

**Conclusão:** Indivíduos normo-ouvintes com queixa de zumbido e hiperacusia apresentaram predomínio de zumbido de pitch agudo, localização bilateral e grau leve. Os sons considerados desconfortáveis foram os de forte intensidade e a reação aos sons mais citada foi à irritação. A dificuldade de compreensão de fala no ruído foi referida pela maioria dos indivíduos.

**Palavras-chave:** audição, zumbido, hiperacusia, questionários.

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## INTRODUCTION

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The tinnitus has become a common otological complaint. It is estimated that approximately 25 million Brazilians present such symptom (1).

A complete anamnesis about the installation of the symptom, description, localization, nuisance caused, among others, is the first action in face of individuals complaining of tinnitus (2). The use of questionnaires is of great value for the assessment of the presence and determination of the degree of severity of the tinnitus (3).

One of the oldest methods still in use to assess the tinnitus is the Acuphenometry (4).

The *Tinnitus Handicap Inventory (THI)* is a questionnaire that seeks to characterize and identify the tinnitus. It is succinct, of easy application and interpretation and reliability for the clinical practice. It addresses the interference of the tinnitus on the patient's quality of life: functional, emotional and catastrophic reactions to tinnitus (5). The THI was translated and validated to Brazilian Portuguese in 2005 by FERREIRA et al (6).

Another complaint that has been found in bearers of tinnitus is the hyperacusis (7, 8, 9, 10). The hyperacusis is a tolerance reaction to environmental sounds, an exaggerated or inappropriate response to sounds that do not cause nuisance to the general population. Its prevalence varies from 9 to 15%, but this percentage is higher in people who present tinnitus (8).

The decrease of noise tolerance is present when the individual reacts negatively to the presence of a sound that would not evoke similar reactions in normal hearers. Such reactions can be of discomfort, fear, nuisance, suffering and others (11). The authors compare the reaction of discomfort of people with hyperacusis (usually for weak sounds) to the reaction of normal individuals in the presence of a high intensity sound.

The hyperacusis occurs in individuals with normal hearing (12, 7). Of the individuals with complaints of tinnitus, only 8 to 20% present normal hearing (13, 12, 7).

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## METHOD

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This is a cross-sectional, descriptive, non-experimental, quantitative study of data obtained from normal hearing volunteers who complained of hyperacusis and tinnitus. To recruit subjects, the research was announced

on the site of Universidade Federal de Santa Maria (UFSM), local papers and radio stations.

The data collection occurred from May to July of 2010, at the Speech-Therapy Service (STS) of UFSM. Participated on the research only individuals who agreed with the methodology of the study, signing the Term of Free and Informed Consent (following Resolution 196/1996).

This study was attached to the Project "Research and database in auditory health", registered at the Ethics in Research Committee, under the number 0138.0.243.246-06.

Through anamnesis was investigated the existence of tinnitus and hyperacusis. Also, it was researched the location (unilateral or bilateral) and the type of tinnitus (if bass or treble). Were included on the study only normal hearing individuals who presented complaints of hyperacusis and tinnitus.

Were considered normal hearing individuals only those that, on the Pure Tone Audiometry, showed air thresholds not above 25 dB in every frequency (14), tympanogram type A (15) and presence of acoustic reflexes.

A visual inspection of the external auditory canal was conducted to discard the presence of obstacles to the realization of PTA. That was performed by air at frequencies of 250, 500, 1000, 2000, 3000, 4000, 6000 and 8000 Hz and through bone transmission at frequencies of 500, 1000, 2000, 3000 and 4000 Hz. The equipment used was the two channel digital audiometer, brand *Fonix*, model FA-12, type 1 and earphones type TDH-39P, brand *Telephonics*.

The tympanometry and the the study of acoustic reflex were determined with the middle ear analyzer of the brand Interacoustics AZ7, with phone TDH-39 and pad MX-41, with probe-tone of 220 Hz at 70 dB NA for tympanometry, and calibration following the norm ISO 389-1991.

The sample consisted of 25 individuals, with ages from 21 to 70 years, being 16 females and 9 males.

To assess the tinnitus was used the Brazilian THI (6). After completed, the points were summed, classifying the tinnitus in degrees: slight, mild, moderate, severe and catastrophic (16).

For the analysis and characterization of hyperacusis, a questionnaire was developed, based on publication by Aita (7) and GONÇALVES, TOCHETTO and GAMBINI (17). The questionnaire addressed aspects such as: sounds considered

uncomfortable (police siren, bell, slamming door, music in normal and loud volume, etc.), difficulty to understand speech in noise, situations that cause discomfort, sensations on the presence of uncomfortable sounds (fear, tension, annoyance, necessity to go away from the sound, tinnitus, etc), use of ear plugs and for how long tolerates these sounds (less than 1 minute, from 1 to 5, from 5 to 10, or more than 10 minutes).

The individuals underwent acuphenometry. In this study, only the *pitch* (sensation of sound frequency) of the tinnitus was researched. According to the type of tinnitus reported by the patient, it was presented a pure tone or a narrow band noise, or else a broadband noise (*white noise*), to the ear contralateral to the tinnitus, thus determining its *pitch*.

In order to verify if there was compatibility between the pitch reported by the patient and the one found in acuphenometry, the narrow band noise and the pure tone above 1 KHz were classified as treble pitch and below 1KHz as bass. The broadband noise, once covers a wide range of frequencies, was considered to be compatible with either reported pitch, treble or bass.

The data were tabled and analyzed descriptively and statistically using the U test of Mann-Whitney and Kruskal-Wallis test. The degree of significance adopted was 5% ( $p < 0.05$ ).

## RESULTS

The analyzed sample consisted of 64% female and 36% male individuals.

From the 25 analyzed individuals, the most common location of the tinnitus was bilateral (84%). Of the 16% who reported unilateral tinnitus, the right ear was predominant (75%) over the left ear (25%). Concerning the *pitch* of the tinnitus, 80% of the individuals reported it as treble.

The results of the degree of tinnitus according to the THI, considering the totality of the subjects studied, are shown in Figure 1. The distribution of degrees of tinnitus in relation to gender is in Table 1.

Table 2 shows the sounds considered uncomfortable, according to the hyperacusis questionnaire.

We considered “other sounds” those with less than five mentions: car started (4), loud laughter (3), fridge noise (3), sound of music at regular volume (2), motorcycle noise (2), alarm clock (2), clapping (1), key noises (1), repetitive noises (1), crying child (1), shower noise (1),

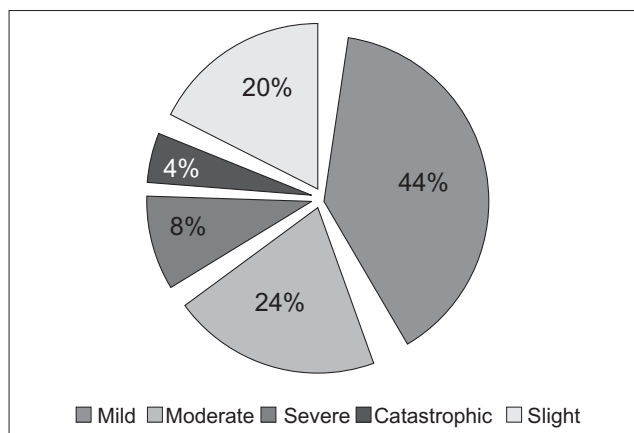


Figure 1. Distribution of the degrees of severity of tinnitus according to THI in all evaluated individuals.

Table 1. Degrees of severity of tinnitus (THI) according to gender.

Degrees of Tinnitus	Male	Female
Slight	2	3
Mild	7	4
Moderate	0	6
Severe	0	2
Catastrophic	0	1
N	9	16

U test of Mann-Whitney ( $p = 0,04^*$ ).

television at regular volume (1), tableware scraping on the plate (1), rockets (1) and microphone interference (1).

Still regarding the hyperacusis questionnaire used, 68% of the individuals reported difficulty in understanding speech in noise. Regarding the situations that cause discomfort, eight answers were obtained. The absence of situations that elicit the discomfort was the most mentioned, followed by “at the end of the day” and “when I’m stressed”.

Table 3 shows the reactions to uncomfortable sounds, according to the hyperacusis questionnaire.

In Table 3, “other reactions” were those with only one mention each: shock, a wish to cry, fear and panic.

As for the use of earplugs, 88% reported not to use them. There was a predominance of 5 to 10 minutes of tolerance time to the sounds considered uncomfortable.

The frequencies most commonly found in the acuphenometry were the treble, especially 6 and 8 KHz. Table 4 shows the results of the analysis by ear, between

**Table 2.** Uncomfortable sounds according to questionnaire applied.

Uncomfortable sounds	n° of mentions (n=25)
Loud music	20
Horn	17
People talking loudly	17
Traffic noise	16
Door slamming	16
Sudden and loud noise	15
Sink dripping	13
Restaurant noise	11
Door bell	11
Police siren	11
Plane	9
Plastic bag noise	7
Blender	7
Phone ringing	6
Others	25

Note: Individuals reported more than one reaction.

the referred *pitch* at anamnesis and the one found in the acuphenometry. It was not possible to apply statistical tests on these findings.

Nine subjects reported tinnitus of bass *pitch*, though such finding was not verified by acuphenometry. That is to say that this individuals identified a treble sound (pure tone or narrow band noise) or white noise instead of the referred bass.

## DISCUSSION

The association between tinnitus and hyperacusis is frequently found in literature: 63% (8, 10), 66,7% (7) and 90% (9). However, we did not find studies that investigate subjects with these two concomitant complaints. Therefore, the obtained data were compared to studies made only with people with hyperacusis and only with bearers of tinnitus.

This study found greater representation of female individuals (64%). Women are more affected both by hyperacusis (61%) (8), and by tinnitus (67,3%) (18), (52,1%).

However, there is controversy in literature about the influence of gender in the prevalence of tinnitus (19). We believe that the higher percentage of women found is due to the fact that they are more available to seek medical care (20), since the female gender prevails in the search for health services (21).

It was observed the prevalence of subjects afflicted by tinnitus of bilateral location (84%). Similar findings,

**Table 3.** Reactions to uncomfortable sounds, according to hyperacusis questionnaire.

Reactions to sounds	n° de mentions (n=25)
Irritation	21
Anxiety	14
Necessity to get away from the sound	13
Tinnitus	11
Tension	11
Disorientation	8
Aggressiveness	5
Headache	4
Pain	2
Dizziness	2
Others	4

Note: Individuals reported more than one reaction.

**Table 4.** Relation between *pitch* reported by patient and the one found in the acuphenometry.

	Pitch - anamnesis		Pitch - acuphenometry	
	Treble	Bass	White noise	Total
Treble	25 (86%)	0 (0%)	4 (14%)	29 (100%)
Bass	6 (67%)	0 (0%)	3 (33%)	9 (100%)

though with smaller percentages, were found by other studies (17, 19). For their turn, FERNANDES and SANTOS (22) found only 20% of the sample reporting bilateral tinnitus.

In this study, the unilateral affection of the right ear was more reported than the left. The study of MARTINES *et al.* (23) goes to meet this finding. But in article by FERNANDEZ and SANTOS (22), the unilateral affection of the left ear was the most common (65%).

The most found *pitch*, both in anamnesis as in acuphenometry (Table 4), was the treble, especially at frequencies of 6 and 8 KHz. Literature also shows treble *pitch* tinnitus as the most reported by patients with tinnitus (22, 23, 24). As in this study, MENEZES and SANTOS FILHA (4) relate higher occurrence of treble tinnitus at the same frequencies.

The most common degree of tinnitus was mild (44%) (Figure 1), which agrees with the findings of MARTINES *et al.* (23) and PAGLIALONGA *et al.* (25), because they found the same degree in normal hearing individuals. On the other hand, PINTO, SANCHEZ & TOMITA (19) obtained higher

percentage of the slight degree and SAVASTANO (26) of the moderate degree, using the same assessment instrument. The low scores found can be explained, since in about 80% of the cases the tinnitus does not cause discomfort for the patient (1, 27).

SAVASTANO (26) found association of slight and mild degrees of tinnitus to individuals who had hearing loss, and moderate to catastrophic degrees associated to individuals without hearing loss, which was not verified in this study. According to this author, a greater degree of hearing loss does not correlate to greater nuisance with the tinnitus.

According to THI, the degree of tinnitus was statistically higher in women (Table 1). This finding can be explained by the greater prevalence of affective disorders, such as anxiety and depression, in women (19), since they are frequently described and associated to a greater nuisance to tinnitus (28).

On the contrary, PINTO, SANCHEZ & TOMITA (19) did not find statistically significant correlation between gender and the nuisance caused by tinnitus, according to THI. These authors refer to depression as a possible indirect influence of gender, showing incidence twice as high in females as in males (29).

The high intensity sounds were the uncomfortable sounds most mentioned by the individuals: high volume music sounds, horn, people talking loudly, traffic noise, door slamming, sudden and high sound, in this order (Table 2).

In study performed with musicians with hyperacusis, GONÇALVES, TOCHETTO & GAMBINI (17) also found, mainly, the high intensity sounds to be discomforting: traffic noise, door slamming, and high volume music. The sounds that started hyperacusis, in AITA's study (7), were: music, sounds of planes and motors in general. Sounds of telephone, doorbell, sirens and slamming doors were also mentioned, but less frequently.

The difficulty to understand speech in noise mentioned (68%) may be deeply connected to the mechanism of tinnitus and hyperacusis, through the Olivocochlear Medial System (OMS); this system acts as a modulator to the activity of the external ciliated cells (ECC) of the cochlea and, among other functions, acts in the recognition of auditory stimuli in the presence of competitive noise (12).

We believe that in, people afflicted by tinnitus, occurs a loss of modulation of the ECC, causing an abnormal auditory pathways activity, misinterpreted as a sound. In hyperacusis, the ECC cease to perform their function of

non-linear amplification, beginning to amplify low and moderate intensity sounds (30). Probably, a cortico-thalamo-olivary pathway is responsible for selective attention and cochlear modulation, both important in the discrimination of speech in the presence of noise (12).

Thus, a disorder of the OMS might cause the tinnitus, hyperacusis and difficulty to recognize speech in noise, as demonstrated by HENNING *et al.* (31). In the mentioned study, normal hearing individuals with complaints of tinnitus and hyperacusis showed lower performance in the presence of noise, with statistically significant difference, when compared to normal hearing individuals without auditory complaints.

The most common reactions to sound were irritation, anxiety, necessity to get away from the sound, tinnitus, tension and disorientation (Table 3). AITA (7) found similar reactions: irritation, tinnitus, headache, hearing decrease, aggressiveness, nausea and anguish. GONÇALVES, TOCHETTO & GAMBINI (17), on the other hand, reported tension, anxiety, necessity to get away from the sound, anger, irritation and pain, being similar to this study, only with different number of mentions.

Hypersensitivity can cause anxiety and even fear, occurring for specific sounds as well as general sounds. This happens because the connections between the central auditory system and the brain areas involved in anxiety and fear are closely connected (32).

Due to these reactions caused by uncomfortable sounds, 12% of the researched individuals reported the use of earplugs. VALENTE *et al.* (33) found constant use of earplugs in severe cases of hyperacusis, because even conversation caused nuisance. According to BAGULEY (32) the first reaction to the hyperacusis is to protect oneself with earplugs or other such devices.

It is noteworthy that auditory overprotection is contraindicated, because it can raise even more the central hearing gain and aggravate the hyperacusis (32). In fact, the *Tinnitus Retraining Therapy*, sound therapy indicated to tinnitus and hyperacusis, is based on auditory desensitization, which involves the gradual removal of earplugs (34).

Most of the subjects questioned reported 5 to 10 minutes of tolerance to sounds considered uncomfortable. AITA (7) found time lower than one hour.

In the acuphenometry (Table 4), the bass *pitch* reported by some subjects was not confirmed. Adding to the results found, MOR (35) also found in acuphenometry prevalence of treble *pitch*, especially at frequencies of 6 to



8 KHz, in normal hearing individuals with complaints of tinnitus.

The absence of relation between the *pitch* reported in the anamnesis and the one found in the acuphenometry may have occurred due to patient's difficulty to compare and associate pure tones or noises to tinnitus, apart from tinnitus being multitoneal, in most cases (24).

## CONCLUSION

Normal hearing individuals with complaints of tinnitus and hyperacusis show prevalence of treble *pitch* tinnitus, located bilaterally and of mild degree. The degree of tinnitus was more accentuated on females.

The high intensity sounds were considered the most uncomfortable. The most mentioned reactions to these sounds were: irritation, anxiety and necessity to get away from the sound. The difficulty to understand speech in the presence of noise was reported by most of the individuals

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