Prevalence of tinnitus complaints and probable association with hearing loss, diabetes mellitus and hypertension in elderly

Prevalência de queixa de zumbido e prováveis associações com perda auditiva, diabetes mellitus e hipertensão arterial em pessoas idosas

**ABSTRACT**

**Purpose:** To assess the prevalence of tinnitus and possible association with hearing loss, diabetes mellitus and hypertension in elderly. **Methods:** Cross-sectional study with individuals older than 60 years who underwent audiological evaluation (pure tone audiometry and history) and answered a comorbidity questionnaire. We evaluated 519 subjects of both genders with a median age of 69 years. Individuals who did not participate in the audiometric test were excluded, then totaling 498 subjects. We applied the appropriate statistical tests to analyze the tinnitus and associated factors. **Results:** The prevalence of 42.77% of tinnitus was found, being 58.68% bilateral tinnitus and 41.31% unilateral tinnitus. There was a difference between tinnitus and hearing loss, but there was no difference between tinnitus and hypertension and between tinnitus and diabetes mellitus alone. **Conclusion:** The prevalence of tinnitus is significant in the elderly. There are differences between tinnitus and hearing loss, with association between the side affected by tinnitus and the side of hearing loss. Only the association of comorbidity of diabetes mellitus and hypertension is an independent risk factor for tinnitus.

**RESUMO**

**Objetivo:** Verificar a prevalência de queixa de zumbido e a possível associação com perda auditiva, diabetes *mellitus* e hipertensão arterial em pessoas idosas. **Métodos:** Estudo transversal com indivíduos com idade superior a 60 anos, submetidos à avaliação audiológica (audiometria tonal e história), e questionário de comorbidades. Foram avaliados 519 indivíduos de ambos os gêneros com mediana de idade de 69 anos. Foram excluídos os indivíduos que não participaram do exame audiométrico, totalizando então 498 sujeitos. Foram aplicados os testes estatísticos apropriados para analisar a queixa de zumbido e os fatores associados. **Resultados:** Observou-se a prevalência de 42,77% de queixa de zumbido, sendo 58,68% bilateral zumbido e 41,31% zumbido unilateral. Houve diferença entre o zumbido e a perda auditiva, porém não houve diferença entre a queixa de zumbido e hipertensão arterial e entre zumbido e o diabetes *mellitus* isoladamente. **Conclusão:** A queixa de zumbido tem prevalência importante nos idosos. Houve diferença entre zumbido e perda auditiva, ocorrendo associação entre o lado afetado pelo zumbido e o lado da perda auditiva. Apenas a associação das comorbidades de presença de diabetes mellitus e de hipertensão arterial é fator independente de risco para o zumbido.

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**Conflict of interests:** nothing to declare.
INTRODUCTION

Hearing loss, tinnitus and vertigo are associated with smoking, high blood pressure (hypertension), diabetes mellitus (DM), lifestyle, age, health history, leisure activities and occupational exposures, and the incidence of auditory symptoms seems correlated with noise exposure during lifetime(1-6).

Presbycusis, which has been cited as the third most chronic condition reported by the elderly, can be defined as the hearing loss associated with aging, reflecting the loss of auditory sensitivity associated with advanced aging. The typical audiometric profile clinically observed in presbycusis is bilateral and symmetrical sensorineural hearing loss at high frequencies that progresses with age, and the tinnitus appears as a symptom of high prevalence and high impact on quality of life of elderly patients(7,11).

Some studies justify that inner ear alterations causing tinnitus, vertigo and hearing loss may be related to a microcirculatory insufficiency resulting from vascular occlusion by embolism, hemorrhage or vasospasm and that these, in turn, would be the result of a hyperviscosity or microangiopathy syndrome caused by DM or hypertension; therefore hypertension could cause sensorineural hearing loss due to these histopathological factors(1,2).

With advancing age, the number of chronic diseases increases and hypertension and systemic alterations in the inner ear present high prevalence in the elderly population(2,12). Many studies have been conducted on the association between hypertension and hearing loss. Some of these studies have verified the existence of a significant association between them(1,2,13).

Individuals with DM often have symptoms such as dizziness, tinnitus and hearing loss, and DM — within the disorders of glucose metabolism — is the condition most commonly related to auditory disorders(13,14).

The purpose of this study was to evaluate the prevalence of tinnitus in the elderly and to verify the possible associations with hearing loss, diabetes mellitus and hypertension.

METHODS

This cross-sectional study was approved by the Ethics Committee of Universidade Norte do Paraná (UNOPAR) under protocol n. 0063/09. This study was part of the first major investigation carried out in the region to assess the health of the elderly aged over 60 years enrolled in Basic Health Units (Unidades Básicas de Saúde; UBS) of Londrina/PR. Participants were of both genders and agreed to voluntarily participate in the study of aging and longevity (Estudo sobre Envelhecimento e Longevidade; EELO) by signing the Instrument of Consent.

The sample was randomly stratified taking into account the five regions of the county. From a population of 43,610 seniors enrolled in 38 UBS from the urban area of Londrina, the calculated sample was composed by 385 individuals. Taking into account probable losses in the population, the sample was increased, reaching 519 individuals, of which: 15% were from the central region, 27% from the northern region, 23% from the southern region, 19% from the eastern region and 16% from the west region. A sampling error of 5% and power of 0.80 were considered for the calculation.

All 519 individuals were evaluated, with the inclusion criteria including independent life and ratings at levels 3 and 4 of Functional Status proposed by Spirduso(15). From these, patients with tinnitus caused by acute problems, such as acute otitis media or stoppers cerumen and people with limitations to the realization of the audiometric testing, such as cognitive impairment or inconsistent responses, were excluded, reducing the sample to 498 individuals.

The routine audiological anamnesis used at the Audiology Clinic of Universidade do Norte do Paraná (UNOPAR) was applied in the current study. The anamnesis is based on the protocol for anamnesis by Miller(16), which consists on otoscopy to examine the external acoustic meatus and the tympanic membrane and pure tone audiometry, considered the gold standard to evaluate the auditory threshold in adults, at the frequencies 250–8000 kHz with presentation of pure tones, initially using 30 dBHL at 1000 Hz. The result was noted in a record form of pure tone audiometry used in the routine care of that sector, and subsequently entered to the database in the program WinAudio to be stored and printed for the patient.

A self-reported questionnaire about comorbidities was also applied, which included questions about age, gender, tinnitus and medical history with data on DM. The audiological evaluation was individually performed in a sound-proof booth with an Interacoustics® audiometer, model AD-28.

The classification used for the determination of hearing loss was the degree, considering individuals without hearing loss those whose tritone average was up to 25 dB, and hearing loss those with tritone average above 26 dB(17).

The dependent variable was the presence of tinnitus. The independent variables were age, gender, hearing loss, DM and hypertension. The variables were descriptively presented in absolute numbers and proportions, estimating prevalence.

The analysis was conducted with non-parametric tests: $\chi^2$ to determine possible associations between tinnitus and individuals with and without hearing loss, DM and hypertension; and logistic regression was performed to verify the independent risk factors for tinnitus.

The value of p<0.05 with a 95% confidence interval (CI) was considered for the univariate analyzes for inclusion in the final model of the $\chi^2$ test and the relative risk. The tests were performed using the software Bio Estat 5.0.

RESULTS

Of the 519 individuals that participated on the EELO project, those who did not attend the exam date were excluded. A total of 498 subjects with a median age of 69 years were submitted to audiological evaluation. Of these, 166 (33.33%) were male and 332 (66.66%) female.
Of the 498 subjects, 285 (57.22%) did not have tinnitus and 213 (42.77%) had tinnitus, being 125 (58.68%) of the sample with bilateral tinnitus and 88 (41.31%) with unilateral tinnitus.

To observe the association between tinnitus and hearing loss according to ear, statistical analysis was performed separately for each ear — 498 right ears with tinnitus and hearing loss, and 498 left ears with tinnitus and hearing loss. There were differences between tinnitus and hearing loss, both for the right ear and for the left ear (Table 1).

**Table 1. Association between tinnitus and hearing loss**

<table>
<thead>
<tr>
<th></th>
<th>Tinnitus RE</th>
<th>Tinnitus LE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presence</td>
<td>Absence</td>
</tr>
<tr>
<td><strong>Hearing Loss</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Control</td>
<td>156 79.59%</td>
<td>193 63.90%</td>
</tr>
<tr>
<td>Total</td>
<td>196 100%</td>
<td>302 100%</td>
</tr>
</tbody>
</table>

χ² test (RE: χ²=13.945, p=0.0002; LE: χ²=8.003, p=0.0047)
**Legends:** RE = right ear; LE = left ear

For the associations between tinnitus, hearing loss, hypertension and DM three individuals who did not respond to the questionnaire of comorbidities were excluded, leading to the total of 495 individuals. Of these, 191 (38.58%) had hypertension only, 27 (5.45%) had DM only, 118 (23.83%) had both comorbidities (DM and hypertension) and 159 (32.12%) had no comorbidity, thus avoiding possible confounding variables.

For each statistical analysis, the number of individuals corresponding to the control group was variable. This was due to the analysis among individuals with tinnitus and associated comorbidity (hypertension or DM), because they were different groups. The statistical analysis was also performed according to ears.

To analyze the association between tinnitus and DM, 27 (14.51%) ears were of diabetic individuals and 159 (85.48%) of individuals with no comorbidity (control). No significant difference was observed (Table 3).

**Table 2. Association between tinnitus and hypertension**

<table>
<thead>
<tr>
<th></th>
<th>Tinnitus RE</th>
<th>Tinnitus LE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presence</td>
<td>Absence</td>
</tr>
<tr>
<td><strong>Hypertension</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Control</td>
<td>79 41.36%</td>
<td>58 36.47%</td>
</tr>
<tr>
<td>Total</td>
<td>112 100%</td>
<td>101 100%</td>
</tr>
</tbody>
</table>

χ² test (RE: χ²=0.869, p=0.3513; LE: χ²=0.856, p=0.2186)
**Legends:** RE = right ear; LE = left ear

Of the 159 right ears, 58 (36.47%) had tinnitus, 13 (22.41%) had normal hearing and 45 (77.58%) had hearing loss; (χ²=2.239; p=0.1345); of 101 (63.52%) ears without tinnitus, 34 (33.66%) had normal hearing and 67 (66.33%) had hearing loss (χ²=2.239, p=0.1345). Of the 159 left ears, 38 (23.89%) had tinnitus being 9 (23.68%) with normal hearing and 29 (76.31%) with hearing loss; of the 121 (76.10%) without tinnitus, 42 (34.71%) had normal hearing and 79 (65.28%) had hearing loss (χ²=1.614, p=0.2040).

The multiple logistic regressions were calculated with 277 left ears, as it was the side that showed higher number of tinnitus case and significant associations. The logistic regression model showed that the presence of DM and hypertension in the same individual (p=0.0472) constitutes an independent risk factor for tinnitus (Table 5).

**Table 3. Association between tinnitus and diabetes mellitus**

<table>
<thead>
<tr>
<th></th>
<th>Tinnitus RE</th>
<th>Tinnitus LE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presence</td>
<td>Absence</td>
</tr>
<tr>
<td><strong>Diabetes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Control</td>
<td>9 33.33%</td>
<td>58 36.47%</td>
</tr>
<tr>
<td>Total</td>
<td>27 100%</td>
<td>159 100%</td>
</tr>
</tbody>
</table>

χ² test (RE: χ²=0.099, p=0.7530; LE: χ²=1.088, p=0.2970)
**Legends:** RE = right ear; LE = left ear

For the association between tinnitus and hearing loss in individuals without comorbidities (absence of DM and hypertension), subjects with both hypertension and DM were excluded to avoid possible confounding variables.

**Table 4. Association between tinnitus and comorbidity (diabetes mellitus and hypertension)**

<table>
<thead>
<tr>
<th></th>
<th>Tinnitus RE</th>
<th>Tinnitus LE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Presence</td>
<td>Absence</td>
</tr>
<tr>
<td><strong>Comorbidity</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>n %</td>
<td>n %</td>
</tr>
<tr>
<td>Control</td>
<td>50 42.37%</td>
<td>58 36.47%</td>
</tr>
<tr>
<td>Total</td>
<td>118 100%</td>
<td>159 100%</td>
</tr>
</tbody>
</table>

χ² test (RE: χ²=0.989, p=0.3199; LE: χ²=3.909, p=0.0480)
**Legends:** RE = right ear; LE = left ear

Of the 42 (34.71%) had normal hearing and 79 (65.28%) had hearing loss (χ²=1.614, p=0.2040).

The multiple logistic regressions were calculated with 277 left ears, as it was the side that showed higher number of tinnitus case and significant associations. The logistic regression model showed that the presence of DM and hypertension in the same individual (p=0.0472) constitutes an independent risk factor for tinnitus (Table 5).

**Table 5. Logistic multiple regression for tinnitus, with independent variables**

<table>
<thead>
<tr>
<th></th>
<th>Intercept – Tinnitus LE</th>
<th>p-value</th>
<th>Odds ratio</th>
<th>95%CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1 – Hearing loss LE</td>
<td>0.0562</td>
<td>1.5611</td>
<td>0.99–2.47</td>
<td></td>
</tr>
<tr>
<td>X2 – Comorbidity</td>
<td>0.0472*</td>
<td>1.7113</td>
<td>1.01–2.91</td>
<td></td>
</tr>
<tr>
<td>X3 – Age</td>
<td>0.9874</td>
<td>0.9997</td>
<td>0.96–1.04</td>
<td></td>
</tr>
</tbody>
</table>

*Significant values (p<0.05) – Logistic Regression
**Legends:** RE = right ear; LE = left ear
DISCUSSION

Due to the high prevalence of hearing loss, and more specifically tinnitus, in the elderly population there is a need to understand its nature and causes in order to improve prevention and develop appropriate interventions. Thus several studies have aimed to verify possible causes of tinnitus(1-3,5,6).

Some studies have found the presence or absence of tinnitus through audiological anamnensis(1,8) due to the ease of verification of the complaint by this method, as it was applied in the current study.

According to the National Institute of Health, tinnitus is a very common symptom, affecting approximately 15% of Americans(19). The prevalence of tinnitus in a preliminary study with the same elderly population detected the symptom in 40% of that population(20).

A study carried out to determine the prevalence of tinnitus in elderly Nigerians and its impact on quality of life found the presence of tinnitus to be 14.1% of the population. The authors concluded that tinnitus is associated with treatable health conditions, such as otitis media, sinusitis, head injury and hypertension(21).

A study conducted in Japan that aimed to determine the prevalence and factors associated with tinnitus in elderly of a Japanese community reported a prevalence of tinnitus of 18.6% (male: 18.0% female: 19.0%)(22). In a study in Australia, the tinnitus was present in 32.7% of people with 60 years of age(23). In the present study, the prevalence of tinnitus was 42.77%.

Some studies show a slightly higher prevalence in females, but rarely reach statistical significance(20,24,25).

Regarding tinnitus complaint, one study(26) reported prevalence in 52% of the elderly sample and there was no difference between men (50%) and women (52.4%). The same occurred with respect to age; the average of 73.15 years for those reporting the complaint and 73.54 years for those who denied it. In the current study there was no difference between men (40.36%) and women (38.85%).

The fundamental mechanism by which insulin and glucose levels could cause alterations of auditory perception is related to impairment of microcirculation, neuropathic factors and the effect of hyperglycemia(25).

All living cells need an adequate supply of oxygen and nutrients to maintain their functions and such supply depends on the functional and structural integrity of the heart and blood vessels. The affection of the circulatory system can impair the functioning of the inner ear. From the described pathophysiological mechanisms, the increase in blood viscosity results in decreased capillary blood flow and oxygen delivery, explaining the relationship between hypertension and tinnitus(5,6,26).

Neuropathy and angiopathy disorders are common in DM. The factors that may cause neuropathy are disturbances in the metabolism of glucose, lipids and vitamins. Angiopathy can occur both directly — interfering with the supply to the cochlea by reducing transport through the thick walls of the capillaries — and indirectly — by reducing the flow or vascular pathways — or it can also cause secondary degeneration of the eighth cranial nerve. However, the relationship between DM and hearing loss would be the presence of hypertension. Knowing that DM is among the factors that predispose to uncontrolled pressure, individuals with DM are twice as likely to develop hypertension. Information on the relationship between both is very useful for developing prevention and detection of such alterations, as well as referrals and treatments. Hypertension is directly related to an increased level of insulin resistance, and some drugs used for the treatment of hypertension worsen this resistance, thus favoring the onset of DM(24-29).

Several studies have attempted to find an association between changes in hearing and DM or hypertension in populations of varying ages. Some studies have found such association(1-3,19), however the comorbidities of DM and hypertension in relation to changes in the auditory system, and more specifically to tinnitus, have not been emphasized in the literature as the current study.

Since this study showed that the presence of DM and hypertension in the same individual is an independent risk factor for tinnitus, the importance of preventive processes that minimize the degeneration mechanisms of hearing, caused by such metabolic and circulatory problems is highlighted.

CONCLUSION

Tinnitus complaint has significant prevalence in elderly. There is a difference between tinnitus and hearing loss, with association between the side affected by tinnitus and the side of hearing loss. Only the comorbidity of diabetes mellitus and hypertension is an independent risk factor for tinnitus.

PCDG contributed with data collection, statistical analysis and writing. JJM collaborated with data collection and sending the manuscript to the journal. LLMM contributed with data collection, analysis and counseling of the study.

REFERENCES