

# Impact of Tinnitus on Quality of Life, Loudness and Pitch Match, and High-Frequency Audiometry

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**Abstract:** Our objective was to compare quality of life, high-frequency audiometry, and loudness-pitch match in individuals with tinnitus with and without hearing loss. We divided 52 individuals into two groups: one with hearing impairment (HI; n = 24) and the other with no hearing loss (NL; n = 28). All participants underwent loudness-pitch match and high-frequency audiometry and responded to the Tinnitus Handicap Inventory (THI) and World Health Organization Quality of Life (WHOQOL) questionnaires. On high-frequency audiometry, older individuals required 77.15% more intensity than did young individuals. On the THI questionnaire, individuals in the NL group exhibited mild handicap, whereas those in the HI group exhibited moderate handicap. On the WHOQOL questionnaires, the HI group demonstrated greater impairment on the physical and psychological domains than did the NL group. Individuals with HI experienced greater discomfort with tinnitus. On high-frequency audiometry, individuals with tinnitus and HI exhibited higher thresholds, with complete hearing loss at some frequencies. The WHOQOL and THI questionnaires revealed that individuals with HI experienced a poorer quality of life than did those with normal hearing.

**Key Words:** hearing loss; quality of life; questionnaires; tinnitus

Tinnitus is defined as a sensation of sound perceived by an individual in the absence of an external sound source, and it affects approximately 15% of the population worldwide [1–3]. A study carried out on a random sample (45% men and 55% women) in a large Brazilian city found that 25% of the interviewees complained of tinnitus [4]. The degree of discomfort caused by this symptom may be mild when perceived by an individual only in particular situations (occurring among approximately 7% of the individuals); moderate when the individual is aware of its existence but does not feel bothered by it; intense when the unpleasant sensation is disturbing and has a negative effect on activities of daily living; and severe when the symptom becomes unbearable, ever-present, and ceaselessly affecting the

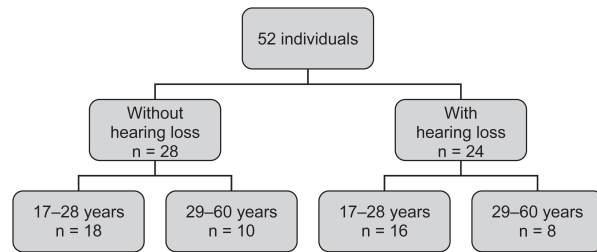
activities of daily living [5]. The degree of discomfort, intolerance, or incapacity caused to the individual is often not related to the loudness (sensation of intensity) of the tinnitus. In 15–20% of cases, tinnitus affects quality of life, with repercussions involving sleep habits, concentration, emotional stability, and social activities [6]. The aim of our study was to compare quality of life, high-frequency audiometry, and loudness-pitch match in individuals with tinnitus with and without hearing loss, according to age group.

## SUBJECTS AND METHOD

This study received approval from the ethics committee of the Universidade Federal de São Paulo-Brazil (process no. 1042/07). All participants signed terms of informed consent. All participants were between 18 and 60 years of age and complained of tinnitus. The sample was made up of 52 individuals divided into two groups (28 with normal hearing [NL group] and 24 with moderate to severe neurosensory hearing loss [HI group]).

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**Figure 1.** Distribution of the sample.

These groups were subdivided according to age: one subgroup up to 28 years and the other older than 28 years.

Figure 1 displays the distribution of the sample, which was selected on the basis of the following criteria:

- Age between 17 and 60 years
- Complaint of tinnitus
- Absence of conductive hearing impairment and/or history of middle-ear abnormalities (otitis, otological surgery, etc.)
- Bilateral type A tympanometric curve
- Absence of syndromes, cognitive deterioration, or apparent psychiatric abnormalities
- Hearing threshold below 25 dB or mean of 500, 1,000, and 2,000 to 25 dB for the group with normal hearing
- Mild to severe neurosensory hearing impairment for the group with hearing deficiency

All individuals selected on the basis of these criteria were submitted to the following evaluations:

1. Patient history: General questions and information on tinnitus characteristics
2. Conventional threshold tonal audiometry (250 and 8,000 Hz): Performed through the airway in individuals without hearing loss and through the airway and bone pathway in individuals with hearing loss
3. Vocal audiometry: Performed with spoken voice, beginning with the obtainment of the speech reception threshold, followed by the speech recognition percentage index
4. Acoustic immittance measures: Tympanometry and study of contralateral acoustic-mode reflex threshold
5. High-frequency audiometry: Study of hearing thresholds in decibels of sound pressure through the airway for pure tones between 9 and 18 kHz, using circum-aural headphones
6. Loudness-pitch match: Performed on the basis of individuals' report of pitch sensation. The frequency was obtained beginning with the conventional range (250–8,000 Hz). When the pitch of

the tinnitus was considered higher than the conventional range, high-frequency stimuli were presented. Loudness was obtained immediately after the obtainment of the pitch using a comparison method, beginning with an intensity of 10 dB above the average of 500, 1,000, and 2,000 Hz, varying in intervals of 5 dB on the basis of patients' sensation.

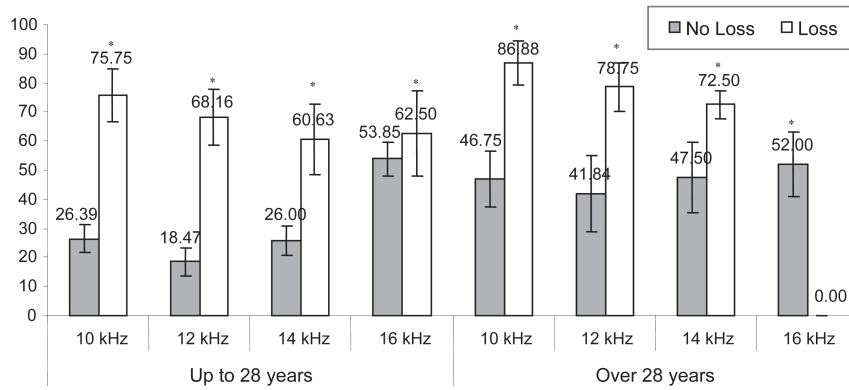
7. THI [7,8] questionnaire: Questions related to the time of the day and circumstances in which tinnitus most disturbed the patient; characterization of the localization and laterality of the tinnitus. The response options were "yes" (equaling 4 points); "sometimes" (equaling 2 points); and "no" (equaling zero). The maximum score on the questionnaire is 100 points, with higher scores denoting a greater degree of handicap that the individuals attribute to tinnitus in their lives.
8. WHOQOL [9,10] questionnaire: Investigation of quality of life, addressing mental health, motor skills, and cognitive and social aspects. The response options are arranged in five-option Likert scales ranging from "very bad" to "very good"; "not at all" to "extremely"; "not at all" to "completely"; "very dissatisfied" to "very satisfied"; and "never" to "always." The scores range from 0 to 5 points for each question, with higher scores denoting a better quality of life based on the individual's perception.

## STATISTICAL ANALYSIS

Nonparametric statistical tests and methods were used in order to compare the results of all procedures between the groups (NL and HI). We used the Mann-Whitney test for the analysis of the questionnaires, high-frequency audiometry, and loudness-pitch match. The level of significance was set at 0.05 (5%), with 95% confidence intervals. Results achieving statistical significance are highlighted with an asterisk (\*).

## RESULTS AND DISCUSSION

Reporting on tinnitus assessed using high-frequency audiometry, a number of authors posit a difference in the threshold between individuals with and without tinnitus [11]. Although we did not include any individuals without tinnitus in the present study, the NL group demonstrated a frequency difference of 18 kHz, as those up to 28 years of age perceived this frequency, whereas older individuals did not (Fig. 2). A number of authors state that age affects high-frequency thresholds [12]. Our study corroborates this, as older individuals had higher

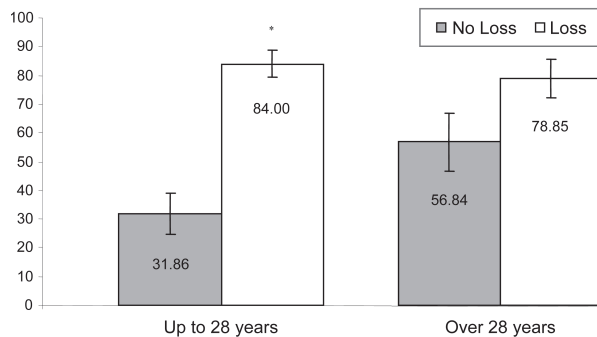


**Figure 2.** Mean high-frequency audiometry values comparing individuals with and without hearing loss according to age group.

high-frequency thresholds, especially in the HI group. Statistically significant differences were found between age groups at frequencies of 10, 12, 14, and 16 kHz (see Fig. 2).

Only the younger individuals (up to 28 years of age) in the HI group perceived frequencies of 10 and 12 kHz. Beginning at 14 kHz, both age groups experienced an absence of response. Comparing the HI and NL groups showed statistically significant differences up to 16,000 Hz, with the NL group requiring less intensity to perceive the frequencies than those in the HI group (see Fig. 2). This may be explained by both the characteristic increase in tonal threshold that accompanies hearing loss and the descending hearing impairment among the individuals selected for the study.

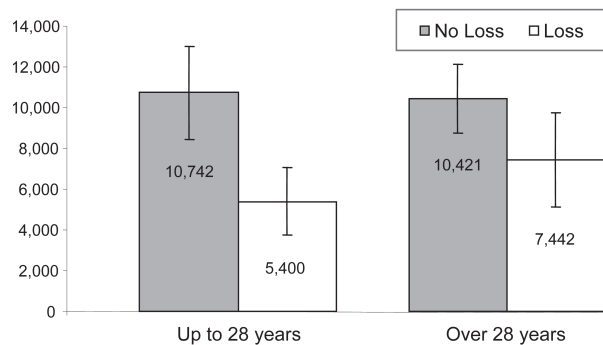
Regarding the loudness-pitch match, a statistically significant difference was evident between age groups among NL individuals, with older individuals exhibiting loudness that was 78.40% more intense than younger individuals (Fig. 3). Among those up to 28 years of age, mean loudness was 31.86 dB of sound pressure, whereas mean loudness among those older than 28 years of age was 56.84 dB of sound pressure. This demonstrates that the older individuals had a greater sensation of intensity than younger individuals. In a previous study, mean loudness ranged from 35 to 40 dB of sound pressure [13].



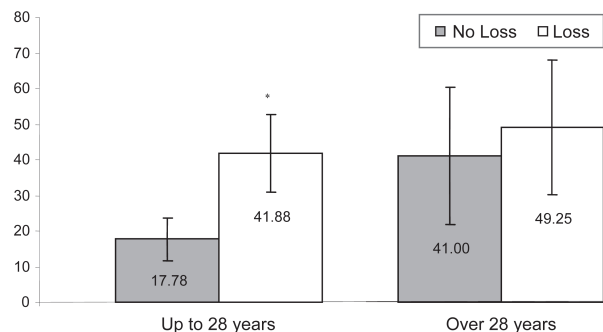
**Figure 3.** Mean loudness values of tinnitus comparing individuals with and without hearing loss according to age group.

Regarding pitch, no statistically significant difference was seen between age groups (Fig. 4). The pitch frequency for the NL group was 10,000 Hz. In previous studies, the frequency found among individuals with normal hearing was 6,000 Hz [13,14]. In our study, mean tinnitus pitch for the HI group was 6,000 Hz, which is similar to results in a study carried out on individuals with acoustic trauma, whose pitch ranged from 6,000 to 8,000 Hz [15].

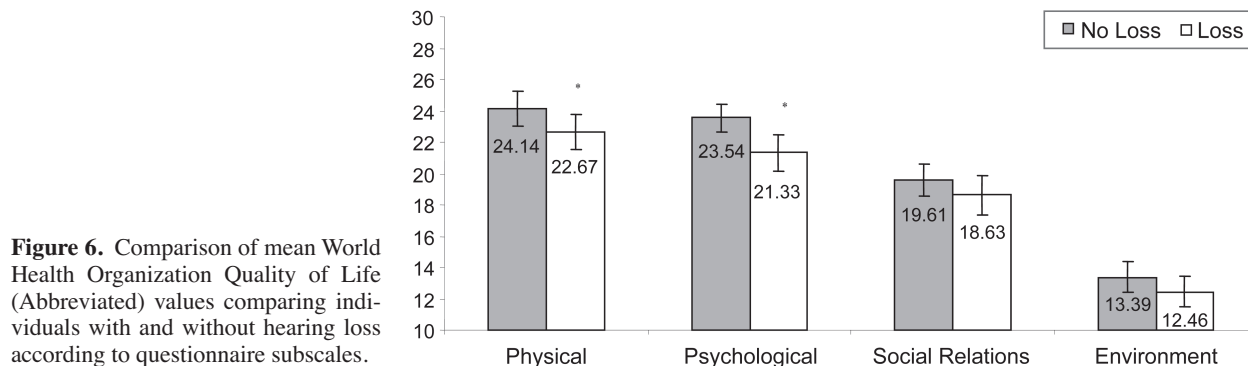
Greater tinnitus intensity in the HI group denoted a worse hearing threshold, which is in agreement with



**Figure 4.** Mean pitch values of tinnitus comparing individuals with and without hearing loss according to age group.



**Figure 5.** Mean handicap values on Tinnitus Handicap Inventory comparing individuals with and without hearing loss according to age group.



**Figure 6.** Comparison of mean World Health Organization Quality of Life (Abbreviated) values comparing individuals with and without hearing loss according to questionnaire subscales.

findings from previous studies [16]. A statistically significant difference was evident between NL and HI groups with regard to loudness (see Fig. 3). The HI group required double the loudness of the NL group, which is explained by the increase in tonal threshold in this group. Furthermore, we observed a statistically significant difference between groups regarding pitch, for which higher frequencies (10,000 Hz) were achieved among the HI group. Among the HI group, pitch was 6,000 Hz, which is a frequency encountered within the conventional range. In a study involving a group with hearing conditions and temporomandibular disorders, the pitch most often encountered was high [9]. The same occurred in our study in the HI and NL groups. However, another study found no prevalence with regard to pitch [17].

Regarding the THI, a previous study found mild handicap (18–36 points) among the group with normal hearing [7]. The same occurred in our study for individuals up to 28 years of age in the NL group (Fig. 5). The authors of the study cited found no significant handicap in the group with hearing loss, whereas in our study, we found moderate handicap (38–56 points) among the HI patients in both age groups, demonstrating that the co-existence of hearing impairment and tinnitus has a greater impact on the life of affected individuals (see Fig. 5). A number of authors believe that the THI questionnaire may be used as a measure for quantifying the impact of tinnitus on daily living [7,8].

Analysis of the WHOQOL questionnaire in the general comparison between groups revealed that the HI individuals scored lower on all the subscales in the NL group (Fig. 6). We found statistically significant differences between those with and without hearing loss on the physical and psychological subscales, which corroborates a previous study that compared individuals with noise-induced hearing loss to those with normal hearing [18].

## CONCLUSIONS

From the results of the present study, various conclusions may be drawn. Individuals with tinnitus and hear-

ing impairment have higher high-frequency thresholds, with complete hearing loss at some frequencies, as compared to those without hearing loss. Among individuals with normal hearing, age affects the thresholds of high-frequency audiometry.

The pitch of the tinnitus is higher among individuals without hearing loss, whereas the opposite is true with regard to loudness. The handicap caused by tinnitus is moderate among individuals with hearing impairment and in older individuals with normal hearing, whereas this handicap is mild among younger individuals with normal hearing. Individuals with hearing loss have a poorer quality of life than individuals without hearing loss, especially in the physical and psychological domains.

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