Effect of Tinnitus on Sleep Quality and Insomnia

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Abstract

Introduction Tinnitus is a conscious perception of a sound resulting from abnormal activity within the nervous system. A relevant percentage of tinnitus patients report symptoms severe enough to significantly affect quality of life, including sleep disorders.

Objective To analyze the sleep quality, insomnia, daytime sleepiness, and risk of obstructive sleep apnea (OSA) in participants with tinnitus.

Methods The sample comprised 18 adults and older adults aged between 18 and 85 years old (mean age = 58.7 ± 17.5 years old), females and males, with complaint of continuous tinnitus for > 1 month. The instruments used were the Tinnitus Handicap Inventory (THI) questionnaire, the Insomnia Severity Index, the Pittsburgh Sleep Quality Index, the Epworth Sleepiness Scale, and the STOP-Bang questionnaire.

Results By means of the THI questionnaire, the tinnitus severity degree reported by most participants was mild (27.8%) and moderate (27.8%), having a positive ($r = 0.582$) and significant (0.011) correlation to sleep quality, measured by means of the Pittsburgh questionnaire. There was a positive correlation between the Insomnia Severity Index and tinnitus handicap ($r = 0.499$; $p = 0.035$). A total of 72.2% of the participants self-assessed their sleep quality as poor, in addition to moderate insomnia (27.8%), although there is low risk of OSA (66.7%), without complaints of excessive daytime sleepiness (72.2%).

Conclusion Subjects with tinnitus complaint self-rated their sleep quality as poor. Moreover, the higher the reported tinnitus handicap, the greater the symptoms of insomnia. There was no influence of tinnitus in relation to daytime sleepiness and no relationship between the severity of tinnitus and the risk of OSA.

Keywords
- hearing
- tinnitus
- sleep
- disorders of excessive somnolence
- sleep initiation and maintenance disorders
- speech-language pathology

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Introduction

Tinnitus is the conscious perception of sound in the absence of external sound stimulus, resulting from abnormal activity within the nervous system, in the absence of any internal or external acoustic stimulus. Subjects suffering from tinnitus often feature severe symptoms that affect their quality of life, such as sleep disorders, difficulties at work and, in some cases, psychological suffering.[1–3]

The prevalence of sleep disorders in subjects with tinnitus has high variability, from 25 to 77%,[4] as reported. However, this can be justified by the variety of instruments and parameters adopted for the diagnosis of sleep disorders, as well as the heterogeneity of the studied population. The main complaint related to subjects with tinnitus is insomnia, occurring in up to 50% of the subjects with severe tinnitus.[5,6] Tinnitus can be associated with several symptoms, with a better prognosis using interdisciplinary therapeutic approaches in subjects with insomnia and tinnitus, which consequently improves in the well-being of these individuals.

In addition to insomnia, another major sleep disorder that may affect subjects with tinnitus is sleep bruxism, related to the functioning of the temporomandibular joints. A study found that patients who suffered from tinnitus and sleep bruxism had a tinnitus with a pitch at higher frequencies (obtained by high frequency audiometry) and at a lower loudness compared with a control group with only tinnitus complaint.[8] The literature also evidences respiratory sleep disorders in patients with chronic tinnitus, verified by means of polysomnography testing, which are more frequent and severe in males.[9] By investigating the risk of obstructive sleep apnea (OSA), greater risk was observed in middle-aged and elderly subjects with tinnitus.[10]

Insomnia, sleep bruxism and OSA are sleep disorders that affect sleep quality and quality of life.[11–13] Studies have shown that, apart from the tinnitus complaint, which can be related to a worse quality of life, due to the perception of this symptom, those subjects also refer to sleep disorders,[4,5,9,10,14] which may have a negative impact on their daily activities and well-being. Thus, it is necessary to investigate the intersection between sleep disorders and tinnitus, as one condition may aggravate the other.

Therefore, the present study aimed to analyze the sleep quality, insomnia, daytime sleepiness, and risk of OSA in subjects with tinnitus.

Methods

The present research was approved by the Ethics Committee on Research with Human Beings of the institution where the study was developed, under the Certificate of Presentation for Ethical Consideration (CAAE, in the Portuguese acronym): 17516219.6.0000.8040, opinion number 3.468.738.

This is an observational, cross-sectional, and descriptive study.

Sampling

The sample comprised 18 adults and older adults aged between 18 and 85 years old, females and males, with 61.1% ($n = 11$) of the sample comprised of females. Initially, the participants were invited to volunteer for the study, and those who agreed signed the Free and Informed Consent Form.

The sample was randomly selected according to the scheduled demand for the audiological screening of the Unified Health System (SUS, in the Portuguese acronym) at the Speech-Language Pathology Clinic in the involved institution, complying with the following inclusion and exclusion criteria:

- Inclusion criteria: Age $\geq$ 18 years old; report of continuous tinnitus complaint for $>$ 1 month; participants who had audiological screening in their medical records; participants who could have hearing loss diagnosis[15] or auditory thresholds within normality standards.
- Exclusion criteria: trouble answering the questionnaires, such as difficulty in understanding the questions, hearing aids users or previous users .

Eight participants were excluded since they did not have all the information in their medical records to contemplate the inclusion and exclusion criteria (three participants did not have the data of their immittance in their records) or did not end the assessment (five participants).

Instruments And Procedures

After signing the Free and Informed Consent Form and undergoing the initial interview, the participants answered the following questionnaires: the Tinnitus Handicap Inventory (THI),[16,17] the Insomnia Severity Index,[18,19] the Pittsburgh sleep quality questionnaire,[20,21] the Epworth Sleepiness Scale,[22,23] and the STOP-Bang questionnaire.[24,25] All questionnaires used in the present study were translated and validated into Brazilian Portuguese.[16,19,20,22,25]

The THI questionnaire[16,17] comprises 25 questions that assess how distressed people are by perceiving their tinnitus and is divided in 3 domains: functional (11 questions), emotional (9 questions), and catastrophic (5 questions). The answer options are: "yes" scores four points; "sometimes" two points; and "no" scores no points. Thus, $<$ 16% is rated as a no or slight tinnitus handicap, between 18 and 36% as a mild handicap, between 38 and 56% as a moderate handicap, between 58 and 76% as a severe handicap, and between 78 and 100% as a catastrophic handicap.[16]

The Insomnia Severity Index,[18,19] a questionnaire encompassing seven questions, graded 0 to 4, was used to investigate insomnia symptoms. For scoring, the responses to the seven questions were added up. Thus, final scoring ranges from 0 to 28, rated as absence of insomnia (from 0 to 7), subthreshold insomnia (from 8 to 14), moderate insomnia (from 15 to 21), and severe insomnia (from 22 to 28).

The Pittsburgh Sleep Quality Index[20,21] was used to assess sleep quality, comprising questions combined to form seven components, with scores ranging from 0 to 3. The components are as follows: subjective sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbance (C5), use of sleeping medication (C6), and daytime sleepiness and daytime dysfunction (C7). The

sum of the scores for the 7 components results in a global score ranging from 0 to 21, and a global score >5 indicates that the subject has poor sleep quality.

The Epworth Sleepiness Scale,[22,23] comprising eight questions related to the possibility of dozing off in daytime situations, was used to verify daytime sleepiness, ranging from zero (0), no possibility of dozing off, to three,[3] high probability of dozing off. The maximum score is 24 points, and scores $\geq$10 indicate excessive daytime sleepiness.

The STOP-Bang questionnaire[24,25] was used to rate the risk of OSA, comprising questions that prompt yes or no answers (scores 1 and 0, respectively), with the total score ranging from 0 to 8. A total score ranging from 0 to 2 predicts low risk of OSA, from 3 to 4 predicts an intermediate risk of OSA, and $\geq$ 5 predicts a high risk of OSA.[25]

Data Analysis

The results of the questionnaires were analyzed in a descriptive and analytical way. The Spearman correlation coefficient, by means of the Statistica 6.0 (TIBCO Software, EUA), was applied to elaborate the correlations between the age, duration of tinnitus perception, THI questionnaire score, and the scores from the sleep-related questionnaires of the participants. A significance level of 5% ($p<0.05$) was considered.

Results

In the present study, the age of the participants ranged from 18 to 85 years old (mean age $=58.7\pm17.5$ years old); 7 of them were males and 11 were females; the duration of tinnitus perception ranged from 2 months to 40 years (mean $=9.2\pm10.5$ years). Regarding tinnitus laterality, 66.7% ($n=12$) reported bilateral tinnitus, 16.65% ($n=3$) reported tinnitus in the right ear, and 16.65% ($n=3$) in the left ear. Tinnitus, reported by the participants, corresponded to a "whistling" sound to 61.1% ($n=11$), to a "hissing sound" to 33.3% ($n=6$), and even as a "waterfall" to 5.6% ($n=1$).

According to the audiological characterization, sensorineural hearing loss was the most frequent disorder, observed in 70.6% ($n=12$) of the sample; 1 participant was diagnosed with conductive hearing loss only in the right ear (5.9%), and another with bilateral mixed hearing loss (5.9%). Regarding the degree of hearing loss, in the right ear, 29.4% ($n=5$) featured moderate degree, 29.4% ($n=5$) moderately severe degree, and 11.8 ($n=2$) mild hearing loss. In the left ear, moderate degree was observed in 35.3 ($n=6$), moderately severe in 23.5% ($n=4$), and mild degree in 11.8% ($n=2$). The most observed tympanometry curve was Type A in 53% ($n=9$), for the right ear, and 64.7% ($n=11$) for the left ear.

Analyzing general tinnitus handicap, $\sim$ 40% of the participants evidenced slight or mild handicap, while 60% of the sample reported moderate to catastrophic handicap. There was no statistically significant correlation between the tinnitus handicap and the variables duration of tinnitus and age (►**Table 1**).

Over 30% of the sample reported complaints of insomnia, 72.2% reported poor sleep quality, 27.8% reported excessive daytime sleepiness, and 11.1% had high risk of OSA. A correlation was found between sleep quality by the Pittsburgh questionnaire and tinnitus handicap by means of the THI questionnaire (►**Table 2**).

Table 1 Scores obtained in the Tinnitus Handicap Inventory questionnaire and their respective correlations between age and duration of tinnitus perception

Tinnitus Handicap Inventory	*n*	%	Age	Duration of tinnitus
No or slight handicap	3	16.7	r = 0.136 *p* = 0.591	r = 0.436 *p* = 0.070
Mild handicap	5	27.8		
Moderate handicap	5	27.8		
Severe handicap	3	16.7		
Catastrophic handicap	2	11.1		
Total	18	100.0		

Statistical test: Spearman's correlation coefficient
*statistical difference ($p<0.05$).

According to the findings, in the THI questionnaire, the degrees of tinnitus severity most reported by participants were mild (27.8%) and moderate (27.8%), with a positive (r = 0.582) and significant ($p=0.011$) correlation to sleep quality, verified by means of the Pittsburgh questionnaire. A total of 72.2% of the participants self-rated their sleep quality as poor, with low risk of OSA (66.7%), and no reports for excessive daytime sleepiness (72.2%) nor for absence of insomnia (38.9%). There was a positive correlation between the THI and the score obtained by the participants in the Pittsburgh questionnaire (r = 0.582; $p=0.011$) and a positive correlation between the Insomnia Severity Index and tinnitus handicap (r = 0.499; $p=0.035$).

Discussion

Tinnitus patients commonly have complaints related to psychological and emotional difficulties, which consequently compromise activities of daily living, and, among these, changes related to sleep disorders can be highlighted.[1–3,26] Therefore, sleep disorders should be investigated in subjects reporting tinnitus so that a precise diagnosis is reached and, consequently, the best therapeutic intervention, according to the needs of the subjects, providing them a better quality of life.

The age from the studied group ranged from 18 to 85 years old, with a mean age of 58.7 years old. A total of 61.1% of the subjects were female. Regarding the tinnitus characteristics, 66.7% ($n=12$) reported bilateral tinnitus, a "whistling' sound (61.1%), and the duration of tinnitus ranged from 2 months to 40 years, with a mean duration of 9.2 years. These findings are similar to those of another study,[27] in which most participants were females and reported symptoms of bilateral tinnitus, and a mean time of symptom perception of 7.8 years. Data in the present study also corroborate findings from a study by Mantello et al., in which 60% of the

Table 2 Correlations between sleep questionnaires and age, duration of tinnitus perception and Tinnitus Handicap Inventory

	n	%	Age	Duration of tinnitus	Tinnitus Handicap inventory
Insomnia Severity Index					
Absence of insomnia	7	38.9	r = 0.016 *p* = 0.950	r = 0.289 *p* = 0.244	r = 0.499 *p* = 0.035*
Subthreshold insomnia	5	27.8			
Moderate insomnia	5	27.8			
Severe insomnia	1	5.6			
TOTAL	18	100.0			
Pittsburgh Sleep Quality Index					
Good sleep quality	5	27.8	r = 0.039 *p* = 0.878	r = 0.056 *p* = 0.826	r = 0.582 *p* = 0.011*
Poor sleep quality	13	72.2			
TOTAL	18	100.0			
Epworth Sleepiness Scale					
Yes	5	27.8	r = − 0.193 *p* = 0.442	r = − 0.457 *p* = 0.057	r = 0.227 *p* = 0.364
No	13	72.2			
TOTAL	18	100.0			
STOP-BANG					
Low-risk OSA	12	66.7	r = 0.272 *p* = 0.276	r = 0.417 *p* = 0.085	r = 0.374 *p* = 0.127
Intermediate-risk OSA	4	22.2			
High-risk OSA	2	11.1			
TOTAL	18	100.0			

Abbreviation: OSA, obstructive sleep apnea.
Statistical test: Spearman's correlation coefficient
*statistical difference ($p < 0.05$);

participants reported bilateral tinnitus,[28] as well as the findings of studies by other authors studies, with ~ 60% of the sample comprising females.[28,29] It should be noted that it is not usual for females to be more prevalent among samples of tinnitus patients, although there are some studies with that distribution.[1,4,6,8]

Most participants were identified with hearing loss (76.5% in the left ear and 82.4% in the right ear), corroborating a study that indicated tinnitus as being associated with subjects with a diagnosis of hearing loss.[26] However, this result does not conform to an epidemiological study that aimed to verify the quality of life in subjects with or without tinnitus complaint. The authors observed that 2,780 out of 11,266 participants reported tinnitus, and that, among those, 84.68% featured normal auditory thresholds, and only 15.32% were diagnosed with hearing loss.[30] Perhaps, the reduced number of the sample, as well as the location of the data collection in the present study (a reference service for audiological screening), has interfered with the findings.

Regarding the degree of severity of the tinnitus, by means of the THI questionnaire (►**Table 1**), 16.7% of the total participants in the present study reported no or slight handicap, while the rest of the sample (83.3%) reported some impact of the tinnitus on their daily lives in a mild (27.8%) or moderate (27.8%) handicap. These results did not conform to a study with a sample comprising only participants diagnosed with hearing loss ($n = 30$), in which 46.5% reported mild tinnitus handicap, 10% reported moderate handicap, and 43.5% reported severe/catastrophic tinnitus handicap, by means of the THI.[28] On the other hand, the study by Nascimento et al., using the THI, observed that most of the sample reported mild tinnitus handicap, followed by moderately severe tinnitus, results that corroborate the ones found in the present study. The difference in tinnitus severity among the studies was explained by Nascimento et al. as being due to the low degree of anxiety, common to the participants in their study, implying that the severity of the symptom may be related or even be aggravated by psychological issues. Similarly to the study by Nascimento et al.,[29] the present study did not aim to assess psychological issues related to tinnitus. No correlation was found between tinnitus handicap and age or duration of tinnitus. Studies correlating the duration of tinnitus perception to the degree of severity of the symptom were not found.

In the analysis of the results from the Insomnia Severity Index (►**Table 2**), 61.1% of the participants reported some symptoms of insomnia, with a positive correlation with tinnitus handicap ($r = 0.499$; $p = 0.035$), which indicates that the higher the tinnitus handicap, the greater the symptoms of insomnia. This result is in line with that of a study that concluded that people with tinnitus perception also suffer from sleep disorders.[5] Sleep quality, by means of the

Pittsburgh questionnaire (►**Table 2**), was self-rated as poor by 72.2% ($n = 13$), corroborating findings in two studies that used the visual analogue scale (VAS) and a sleep-related questionnaire to observe the influence of tinnitus on quality of life and sleep. In both studies, 50% of the sample reported impact on their sleep quality.[14,31] Therefore, the difficulties related to sleep quality can be a reflex, in subjects with tinnitus, of their emotional status, with negative impact on their activities, including sleep-related issues.

Assessing sleep quality and tinnitus severity handicap (►**Table 2**), there was a positive ($r = 0.582$) and statistically significant correlation ($p = 0.011$) between the findings, which showed that the higher the THI score, the worse the sleep quality scores. This result was also evidenced in a study that assessed 44 subjects with tinnitus and significant symptoms related to sleep disorders using the Pittsburgh questionnaire (PSQI). The tinnitus group featured higher PSQI scores than the control group, unveiling worse self-rated, subjective sleep quality.[32] Wakabayashi et al.[33] investigated the tinnitus severity degree (using the THI questionnaire), the sleep quality (by means of the PSQI), depression and anxiety symptoms in a sample of 100 participants. They evidenced mild tinnitus handicap in 15.3% of the subjects, with 29.3% reporting moderate tinnitus handicap, and 17.2% reporting catastrophic tinnitus handicap. Regarding the Pittsburgh questionnaire, the mean score was 7.8, and 66% of the participants self-rated their sleep quality as poor.[33] These results show that the presence of the complaint of poor sleep quality is frequent in those subjects, regardless of the degree of the tinnitus handicap.

There was no correlation between the duration of tinnitus and the Epworth Scale (►**Table 2**). This finding disagrees with the study by Teixeira et al.,[34] who used the Epworth questionnaire and polysomnography testing in subjects with tinnitus and observed that those subjects evidence changes in their sleep architecture, featuring lighter sleep, and that, consequently, they may have more daytime sleepiness.

Possibly, worse sleep quality in those subjects occurs because, during the night, environmental noise decreases, and the tinnitus perception and attention may increase, causing anguish and anxiety, which may influence sleep quality in a negative way. Kleinstäuber et al.[35] verified the correlation between the THI and anxiety symptoms, as well as sleep disorders, evidencing that higher THI scores seem to be associated with symptoms of anxiety and sleep disorders.

Comparing the findings of the present study with the literature, differences are perceived in the sample size used in each study. Therefore, some data did not show statistical significance. Even though the present study has limitations, it shows the theme relevance, suggesting that further studies, with higher number of participants, be developed to investigate sleep disorders in subjects with tinnitus complaints. Thus, it is necessary to search for strategies aiming at therapeutic interventions for tinnitus, and also at improving the quality of life of these subjects.

Conclusion

In the present study, 60% of the sample reported moderate to catastrophic tinnitus handicap and issues related to sleep. It was concluded that the participants with tinnitus complaint self-rated their sleep quality as poor. It was also concluded that the higher the reported tinnitus handicap, the more symptoms of insomnia. There was no influence of tinnitus in relation to daytime sleepiness, just as there was no relationship between the severity of tinnitus and the risk of OSA. Thus, through the results found in the present research, it is encouraged that new studies contribute to clarify the understanding of the relationship between sleep and tinnitus.

Contributions of the Authors

Gallo K. E. B.: data collection, tabulation, literature review and manuscript writing.
Corrêa C. C.: project and study design, in addition to general supervision of the performance steps and manuscript elaboration.
Gonçalves C. G. O.: literature review, manuscript writing and final revision.
Correia J. B.: literature review, manuscript writing and final revision.
Marques J. M.: interpretation of data and final revision.
Zeigelboim B. S.: literature review, manuscript writing and final revision
José M. R.: project and study design, in addition to general supervision of the performance steps and manuscript elaboration.

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Conflict of Interests

The authors have no conflict of interests to declare.

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