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Intensity and discomfort of post-COVID-19 tinnitus: a comparative study

Intensidade e desconforto do zumbido pós-COVID-19: um estudo comparativo

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ABSTRACT

Purpose: to characterize the degree of intensity and discomfort of tinnitus in post-COVID-19 individuals. **Methods:** observational, exploratory and cross-sectional research with 242 participants, divided into two equal groups matched according to sex and age group. The control group, composed of individuals with tinnitus in the pre-pandemic period, and the study group, composed of participants who reported post-COVID-19 tinnitus in different regions of the country. General and domain-specific scores from the Tinnitus Handicap Inventory (THI) and Visual Analogue Scale (VAS) were compared through descriptive statistical analysis, normality tests, comparison of groups and correlation between variables. **Results:** in each group, 93 participants were female and 28 male, with a mean age of 35 years. The "negligible" and "mild" degrees of the THI and the "mild" and "moderate" of the VAS were higher for the SG, while the catastrophic domain of the THI and the VAS indicate worse scores for the CG. There was a significant difference between all domains of the inter- and intra-group scales. **Conclusion:** milder manifestations of post-COVID-19 tinnitus disturbance, intensity and discomfort were found, compared to symptoms arising from other causes. Thus, the self-reported impact of the studied population was lower, pointing to better therapeutic and prognostic possibilities.

Keywords: COVID-19; Pandemic; Tinnitus; Hearing disorders; Disease impact profile

RESUMO

Objetivo: caracterizar o grau de intensidade e desconforto do zumbido de indivíduos, pós-COVID-19. **Métodos:** pesquisa observacional, exploratória e de corte transversal com 242 participantes, divididos em dois grupos iguais, pareados de acordo com gênero e faixa etária: grupo-controle (GC), composto por indivíduos com zumbido em período pré-pandêmico, e grupo de estudo (GE), composto por participantes que referiram zumbido pós-COVID-19, de diferentes regiões do país. Foram comparados os escores gerais e de domínios específicos do *Tinnitus Handicap Inventory* (THI) e da Escala Visual Analógica (EVA), por meio de análise estatística descritiva, testes de normalidade, comparação de grupos e de correlação entre as variáveis. **Resultados:** em cada grupo, 93 participantes eram do gênero feminino e 28, do masculino, sendo a média das idades de 35 anos. Os graus desprezível e leve do THI e leve e moderado da VAS foram maiores para o GE, enquanto o domínio catastrófico do THI e a EVA apontaram piores escores para o GC. Houve diferença significativa entre todos os domínios das escalas inter e intragrupos. **Conclusão:** manifestações mais brandas de incômodo, intensidade e desconforto do zumbido pós-COVID-19 foram encontradas, em comparação ao sintoma decorrente de outras causas. Assim, o impacto do zumbido para a população estudada foi menos autorreferido, apontando para melhores possibilidades terapêuticas e prognósticas.

Palavras-chave: COVID-19; Pandemia; Zumbido; Transtornos da audição; Perfil de impacto da doença

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INTRODUCTION

Characterized as the conscious perception of sound in the absence of any corresponding acoustic stimulus, tinnitus is one of the most recurrent auditory symptoms nowadays[1]. It is a symptom with a multifactorial cause and can affect different aspects, including cognitive, behavioral, mental health, and others[2,3].

COVID-19 and its repercussions is currently associated with the increase in tinnitus complaints. National[4] and international[5-7] data point to tinnitus complaints in people with SARS-CoV-2 infection. The action of COVID-19 on hearing goes beyond SARS-CoV-2 and can be considered in three main ways: viral action on auditory structures, due to systemic disorders triggered by the virus, adverse effects of medications to reduce symptoms of the disease, or vaccines.

The mechanisms of damage to the peripheral auditory system include direct viral damage to the organ of Corti, stria vascularis, or spiral ganglion, damage mediated by the patient's immune system against proteins expressed by viruses, and immunocompromise leading to secondary bacterial infection from the ear. Damage to the auditory system secondary to viral infections is typically intracochlear; however, it can also affect the auditory brainstem and the brain[8].

There is a physiological relationship between the high binding of the virus to angiotensin-converting enzyme 2 (ACE-2) and the overabundance of this protein in brain structures, smooth muscles, and other body structures, which may facilitate the entry of the virus into different systems bodies, causing the most diverse disorders in body homeostasis[9,10]. Among these brain structures, common areas between hearing and cognition can be affected.

Cure and Cumhur Cure[9] report that the overexpression of ACE2 (angiotensin-converting enzyme) in the brain has a positive effect as an anti-inflammatory antioxidant and blood pressure regulator. However, if the cytosolic pH (hydrogen ion potential) is low, an increase in ACE2 may be triggered, causing an increase in the viral load, which may cause the infection to progress to more severe conditions, leading the virus to release excess cytokines, and occupying the auditory cortex and/or adjacent structures, causing consequent auditory damage of oxidative increase. This happens because the viral infection in the erythrocytes deoxygenates them, therefore, excessive activation of the virus in the auditory cortex can damage it and make it hypoxic[9].

We should also consider the impact of COVID-19 on mental health, especially in individuals with chronic manifestations, such as tinnitus. Beukes et al.[11] indicate an increase in the perception of tinnitus in patients with higher rates of depression, anxiety, irritability, and financial concerns triggered during the pandemic period. Also, other research supports these findings when they associate the increased perception of tinnitus with greater exposure to the effect of environmental stressors related to COVID-19 and its aspects[8,11,12].

Thus, this study aimed to characterize the degree of intensity and discomfort of tinnitus in individuals, post-COVID-19.

METHODS

This is an observational, retrospective, exploratory and cross-sectional study, with approval by the Research Ethics Committee of the Health Sciences Center of the *Universidade Federal da Paraíba* - CEP/CCS/UFPB, under number 4,297,779, with the signing of the Informed Consent Form as a mandatory item for participation. The sample (for convenience) consisted of 242 participants, divided into two equal groups, paired according to gender and age group.

The control group (CG) consisted of 121 individuals with tinnitus, who reported the symptom since the pre-pandemic period and who make up the database of a research group on hearing, balance, and tinnitus at a Brazilian higher education institution. These participants had tinnitus of different etiologies and degrees and sought the research group for better health notes and relief of symptoms, since the research group offers a wide network of multidisciplinary care and different therapeutic possibilities, free of charge, for the community. The study group (SG) consisted of 121 participants who had post-COVID-19 tinnitus, the result of local research (from the same region as the CG) of national research[4].

The SG inclusion criteria were being a minimum of 18 years old; testing positive for COVID-19; having internet access to fill in the forms and being in full mental faculties. Individuals who were in the acute phase of the infection or hospitalized at the time of the survey were excluded from the sample; in addition, exposure to noise at work was also considered an exclusion criterion. For the CG, the minimum age of 18 years old and complete Tinnitus Handicap Inventory (THI) and Visual Analog Scale (VAS) forms in the database were analyzed as inclusion criteria, and exposure to occupational noise was excluded.

For both groups, the general scores and specific domains of THI and VAS were compared. The THI analyzes the degree of general discomfort associated with tinnitus, being subdivided into three domains[13,14]: functional domain, which measures the discomfort caused by tinnitus in mental, social, occupational, and physical functions; emotional domain, which determines affective responses such as anxiety, anger and depression; and catastrophic domain, which quantifies despair and the inability referred by the affected person to live with or get rid of the symptom. Answers are scored from 0, when tinnitus does not interfere with the patient's life, to 100 (points or %), when the degree of annoyance is severe. The sum of the points resulting from the questions is categorized into five groups or degrees of severity: negligible (0-16%); mild (18-36%); moderate (38-56%); severe (58-76%) and catastrophic (78-100%)[13,14].

VAS is indicated for measurement related to tinnitus discomfort and intensity. For analysis purposes, the following subdivision was adopted[15,16]: mild, for those who selected scores between 0 and 2; moderate, between 3 and 7 and intense, between 8 and 10. The data were statistically analyzed, comparing the results found from the THI and the VAS between the SG and the CG.

Data were tabulated in the Statistical Package for Social Sciences (SPSS) software, version 23, trial, and analyzed using four different types of statistical analysis: descriptive statistical analysis; normality tests; group comparison tests, and correlation tests between variables. Descriptive statistical analysis was used to obtain synthetic data about the sample, such as frequency, percentage, minimum/maximum, mean and standard deviation.

The Kolmogorov-Smirnov test was used since it has a sample of more than 50 individuals. For the group comparison tests, data normality was not verified, both in the variables of the total sample and in the division by groups. Thus, the Pearson Chi-Square test was adopted to compare qualitative variables and the Mann-Whitney U test for quantitative variables between groups.

For analysis of the relationships between the variables, the non-parametric Spearman Correlation test was used since there was no normality in the data. For all tests, a significance level of less than 5% ($p<0.05$) was considered.

RESULTS

Each group had 121 participants, of which 93 were female and 28 were male. The average age for both groups was 35 years, ranging from 16 to 73 years old. The comparative analysis of the study variables revealed proximity between the general results, except some THI and VAS degree scores. We noted that the VAS mild and moderate degrees were higher for the SG (Table 1).

As for the comparison between the general scores of the THI and VAS domains for both groups, we observed a significant relationship between the groups in the catastrophic THI domain and the VAS, both presenting worse scores for the control group (Table 2).

As a result of the correlation tests between the variables, a significant difference was observed between all the THI domains and the VAS scores, showing a positive and strong correlation, between the domains and the overall THI degree (Table 3).

DISCUSSION

The post-COVID-19 syndrome is characterized as a set of symptoms and/or physical, mental, and cognitive sequelae,

Table 1. Comparison test of variables between groups

Variable		Group	n[1]	%[2]	Test statistics **	p-value
Gender	Female	Control	93	76.9	0.000	1.000
		Study	28	23.1		
	Male	Control	93	76.9		
		Study	28	23.1		
THI[3] Degree	Negligible	Control	25	20.7	4.288	0.368
		Study	27	22.3		
	Mild	Control	25	20.7		
		Study	37	30.6		
	Moderate	Control	28	23.1		
		Study	22	18.2		
	Severe	Control	25	20.7		
		Study	18	14.9		
	Catastrophic	Control	18	14.9		
		Study	17	14.0		
VAS[4] Degree	Mild	Control	8	6.6	11.576	0.003*
		Study	24	19.8		
	Moderate	Control	64	52.9		
		Study	65	53.7		
	Severe	Control	49	40.5		
		Study	32	26.4		

Source: Research data; *Significant data; **Mann-Whitney U/Pearson Chi-Square test
Subtitle: n[1] = Frequency; %[2] = Percentage; THI[3] = Tinnitus Handicap Inventory; VAS[4] = Visual Analog Scale

Table 2. Comparison of scales between groups

Variables		Group	Minimum	Maximum	Mean	SD[1]	Test**	p-value
Age		Control	16	73	37.15	11.71	7124.5	0.719
		Study	19	73	36.60	11.16		
THI[2]	Functional	Control	0	44	19.11	12.33	6553.5	0.158
		Study	0	42	16.86	12.13		
	Emotional	Control	0	36	16.71	11.11	6557.5	0.160
		Study	0	36	14.76	11.21		
	Catastrophic	Control	0	40	10.69	6.87	6209.5	0.040*
		Study	0	20	8.89	5.62		
	Total	Control	0	98	45.96	27.00	6468.5	0.118
		Study	0	98	40.51	27.36		
VAS[3]		Control	2	10	6.45	2.37	5696.5	0.003*
		Study	0	10	5.33	2.92		

Source: Research data. *Significant data; **Mann-Whitney U test
Subtitle: SD[1] = Standard Deviation; THI[2] = Tinnitus Handicap Inventory; VAS[3] = Visual Analog Scale

Table 3. Correlation analysis between study variables

Variable 1	Variable 2	Correlation**	p-value
THI Functional	THI Emotional	0.823	0.000*
	THI Catastrophic	0.701	0.000*
	THI Total	0.933	0.000*
	THI Degree	0.899	0.000*
	VAS	0.572	0.000*
	VAS Degree	0.518	0.000*
THI Emotional	THI Catastrophic	0.785	0.000*
	THI Total	0.946	0.000*
	THI Degree	0.924	0.000*
	VAS	0.614	0.000*
	VAS Degree	0.564	0.000*
THI Catastrophic	THI Total	0.858	0.000*
	THI Degree	0.836	0.000*
	VAS	0.556	0.000*
	VAS Degree	0.525	0.000*
THI Total	VAS	0.629	0.000*
	VAS Degree	0.579	0.000*
THI Degree	VAS	0.592	0.000*
	VAS Degree	0.544	0.000*

Source: Research data; *Significant data; **Spearman Correlation Test
Subtitle: THI = Tinnitus Handicap Inventory; VAS = Visual Analog Scale

persistent after recovery from the acute phase of the disease[17]. Audiovestibular symptoms, such as tinnitus, dizziness, and ear fullness, triggered during COVID-19, remain in some patients for a certain period[4], composing the main audiovestibular findings of the post-COVID-19 syndrome[18].

In this study, 121 people (adults and elderly people) with post-COVID-19 triggered tinnitus participated. In the national scenario, authors[4,19] point out that tinnitus is the most persistent auditory symptom triggered by COVID-19. Other factors may also be associated with triggering tinnitus, which may be related to metabolic, hormonal, mental, auditory, muscular, and other disorders[20]. Thus, comparing the impact of this symptom caused by COVID-19 and factors associated with tinnitus with manifestations already known and described in the literature will lead to a better understanding and characterization of this unique manifestation.

When comparing the scores of the tinnitus annoyance severity scale domains between the groups of this study with the THI, we observed that the SG participants were predominant in the negligible and mild degrees, while those in the CG reported higher rates of moderate to catastrophic (Table 1). This data reports that post-COVID-19 tinnitus presents less discomfort when compared to tinnitus resulting from other factors, a result also verified in the study by Tseng et al. (2021)[21], which demonstrates that patients with post-COVID-19 tinnitus tend to present manifestations with milder discomfort and, therefore, point to greater trends in symptom reduction and/or remission over time. However, there are no indications that age or duration of tinnitus systematically influences the occurrence or remission of tinnitus[22] since other studies[23,24] have inferred a reduced probability of tinnitus improvement with longer perception/duration (more chronic).

Differences between individuals in their self-perception of tinnitus and related discomfort may be related to the overlapping of different diagnoses, considering that patients with other conditions are exposed to a sum of symptoms that may reflect on their self-perception of tinnitus, worsening the discomfort scores[25]. Another factor related to this result was the use of a previous database to compare the symptom, considering that the participants in the control group sought a health service, as tinnitus was already a factor of discomfort and/or concern for them, while the study group participants were found by the research and sometimes did not characterize tinnitus as something with discomfort.

Moreover, regarding the degree of discomfort, we observed that the main differences were related to the catastrophic domain of the THI, in which patients in the CG had worse scores. The catastrophic domain is related to despair and the inability to live with the symptom, often triggered by the perception that tinnitus results from neural and/or oncological pathologies[26]. The SG participants noticed the onset of tinnitus during or shortly after the acute phase of the new coronavirus infection, in which many have already attributed the symptom to COVID-19, reducing fear and uncertainties in other comorbidities, unlike the CG and reflecting the smallest expression of this domain of the scale. Due to greater concerns in this period (unemployment, general health, and preventive measures), attention to tinnitus may have been minimized given the new problems.

The emotional and functional domains of the THI also had higher scores in the CG, however, remarkably close to those of the SG. This indicates that, despite the pandemic being a stressor for mental health and, sometimes, a trigger for the onset of anxiety, stress, and depression[27], the emotional aspects of the SG individuals with tinnitus had a similar presentation to those of the CG. This fact is in line with another study[11] that supports the idea that greater contact time with the family, greater ease, and availability of time for online therapies, among other factors, collaborate to reduce the suffering from tinnitus and consequent improvement in the annoyance domain scores.

As for the discomfort and intensity, the SG participants were predominant in the mild and moderate degrees of the VAS, while, in the CG, the intense and general degrees prevailed (Tables 1 and 2). Thus, the indicators of discomfort and intensity pointed to a lower projection in tinnitus due to factors associated with COVID-19. This fact was also observed in the study by Aazh et al.[28], in which the authors point out that the intensity, annoyance, and discomfort scores did not differ significantly for the groups analyzed before and during the pandemic, as well as the changes in psychological well-being or stress resulting from social isolation did not significantly affect tinnitus severity ratings.

In line with the international literature[8,11,21,27,28], this study pointed out that the findings of annoyance, discomfort, and intensity of post-COVID-19 tinnitus showed milder manifestations when compared to the condition resulting from other already known factors, showing a significant correlation between the degrees and general and specific domains of THI and VAS (Table 3). The significance of these results reaffirms the correlation between these scales and their value for measuring tinnitus. National and international studies[29,30] agree with this thought, recommending the combination of these scales to measure aspects of self-perception of tinnitus.

The next steps of this research will analyze and categorize the main factors associated with triggering and/or worsening post-COVID-19 tinnitus, as well as analyze the risk of developing the symptom as a result of COVID-19 and other variables. As limitations of the study, we highlight the absence

of further information on the participants in the database before the pandemic and the limited number of variables for cross-referencing between the groups.

CONCLUSION

When compared to individuals with pre-pandemic tinnitus, participants with post-COVID-19 symptoms had lower annoyance, intensity, and discomfort scores. Negligible and mild THI and mild and moderate VAS degrees were more referred to in the post-COVID-19 group. Thus, the impact of the symptom triggered during this period was less intense, as reinforced in the most recent literature. The use of THI and VAS to measure these characteristics showed a significant value for both groups, reaffirming their parametric legitimacy.

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