Association between tinnitus and anxiety in the convalescent COVID-19 patients: A single-center observational study

Original Article

Reham Mamdouh Lasheen[a], Mohamed Osama Tomoum[b]

Department of [1]Audiovestibular Medicine, [2]Otorhinolaryngology, Faculty of Medicine, Tanta University, Egypt.

ABSTRACT

Introduction: After contracting COVID-19, some patients experienced tinnitus even though they did not have any hearing loss.

Objectives: To investigate if COVID-19 infection-related anxiety may be the cause of tinnitus development in individuals who did not experience hearing loss.

Patients and Methods: Our study included 120 participants with bilateral normal peripheral hearing who were divided into three groups. The control group (group I) consisted of 40 patients who did not have any otological complaints or a history of COVID-19 infection. The other two groups had a history of COVID-19 infection; 40 patients of them had no otological complaints (group II), while the other 40 patients reported bilateral tinnitus after COVID-19 infection (group III). All subjects underwent Tinnitus Handicap Inventory (THI) and Hamilton Anxiety (HAM-A) and measurement of the levels of inflammatory markers.

Results: Study group III showed statistically significant higher scores than the other two groups in THI, HAM-A, and the level of inflammatory markers.

Relation between patient's results and types of graft used showed no statistically significant differences between them.

Conclusion: Tinnitus that developed in some normal hearing subjects after infection with COVID-19 may be caused by anxiety and stress.

Key Words: Anxiety, COVID-19, Hamilton Anxiety (HAM-A), inflammatory markers, tinnitus, Tinnitus Handicap Inventory (THI).

Received: 13 June 2022, **Accepted:** 1 September 2022

Corresponding Author: Reham Mamdouh Lasheen, PhD, Department of Audiovestibular Medicine, Faculty of Medicine, Tanta University, Egypt. **Tel.:** +201224882153, **E-mail**: Doctor_rl2006@yahoo.com

ISSN: 2090-0740, 2022

INTRODUCTION

The World Health Organization (WHO) classified COVID-19 as a global pandemic in March 2020.[1] Coronavirus disease 19 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2).[2] It first appeared in the Chinese city of Wuhan and quickly spread over the world.[3] Its case fatality rate is 2.3% higher than that of Influenza, and it is more contagious than severe acute respiratory syndrome (SARS).[4]

Social isolation, quarantine, and travel restrictions reduced the workforce across all economic sectors, resulting in the loss of numerous employments. The demand for medical supplies has skyrocketed, and the food sector has seen a surge in demand due to the panic-buying and hoarding of food supplies. These circumstances have disrupted the population's psychosocial life, causing feelings of fear, anxiety, and other mental disorders.[5, 6]

Tinnitus is a condition in which a person perceives sound without any external auditory stimuli.[7] Tinnitus is highly associated with psychological comorbidities such as anxiety and depression disorders.[8,9,10]

The pathophysiology of tinnitus is unknown, however, it has been suggested that it is linked to stress and anxiety factors, as well as increased levels of inflammatory markers such as Neutrophil lymphocyte ratio (NLR), platelet lymphocyte ratio (PLR), mean platelet volume (MPV), and C reactive protein (CRP).[11, 12]

Despite having normal hearing levels, we have observed an upsurge in tinnitus cases among the recovered COVID-19 patients. This concurs well with the results documented by Elibol E. *et al*.[13], and Ozcelik KM. *et al*.[14]. Thus, our primary research outcome was to investigate the correlation between COVID-19 infection-related anxiety and the development of tinnitus in the recovered COVID-19 patients with normal hearing levels, utilizing the Tinnitus Handicap Inventory (THI) and Hamilton Anxiety (HAM-A) Scales. The secondary research outcome was to compare the levels of inflammatory markers [neutrophil to lymphocyte ratio (NLR) and platelet to lymphocyte ratio (PLR)] between healthy individuals and patients who experienced tinnitus after contracting COVID-19

 DOI: 10.21608/ejentas.2022.140705.1527

infection. The levels of these inflammatory markers were also correlated with the degree of tinnitus (tinnitus loudness and tinnitus handicap inventory).

PATIENTS AND METHODS:

A. Subjects:

Our study included 120 participants; whose ages ranged from 18 to 45, they were divided into three groups. The control group (group I) consisted of 40 patients who did not have any otological complaints or a history of COVID-19 infection. The other two groups had a history of COVID-19 infection in the previous year diagnosed by PCR and CT chest studies, 40 patients of them had no otological complaints (group II), while 40 patients reported bilateral tinnitus after COVID-19 infection (group III). All the participants in our study had bilateral normal peripheral hearing determined by the pure tone audiometry (PTA) as well as normal middle ear function as evidenced by otologic examination and tympanometry. We excluded patients with a history of tinnitus before COVID-19 infection. Patients with any possible identifiable cause of tinnitus were excluded through systemic, head and neck, and otolaryngologic examinations. We have also excluded patients with systemic diseases (e.g., anemia, hormonal disturbance, cervical diseases) that may cause tinnitus or alter the inflammatory markers. Investigations e.g., blood glucose level, lipid profile, hepatic function tests, renal function tests, and thyroid function tests, have been conducted to exclude the other causes of tinnitus. Age and sex were matched between the control and the study groups.

We conducted our study at Tanta University hospital, and the institutional ethics committee of the University of Tanta approved our study. All the participants provided informed written consent before contributing to the research. The study was conducted from September 2020 to June 2021.

B. Method:

To rule out various causes of tinnitus, we performed a comprehensive systemic examination, otolaryngological examination, personal and medical history from all the participants in the three groups. Detailed tinnitus history (characters of sound perceived by the patient, loudness, and duration of tinnitus) was retrieved from all the participants in group III. The duration of tinnitus in group III ranged from 7.2± 4.91 months.

Basic audiological evaluation by GSI pure tone audiometer version 61 audiometer (Viasys- USA) using the headphone TDH 39. Immittancemetry by interacoustics AT235H impedance using a low frequency 226 Hz probe tone (Middelfart, Denmark). Averages of Pure-tone (PTA) thresholds were calculated at frequencies of 0.5, 1, 2, and 4 kHz. The normal hearing was based on the criteria of the American Speech-language- Hearing Association (ASHA, 1978)[15] of a PTA threshold below or equal to 20 dBHL.

The Arabic version of the Hamilton anxiety scale (HAM-A):

We utilized the validated Arabic HAM-A scale[16] as a tool to assess the severity of the anxiety in the control and the study groups. It consists of 14 items, each item consists of a group of symptoms which is rated on a scale from zero to four, where zero indicates no symptoms, and four indicates very severe symptoms, with the total score ranging between 0 and 56. Scores of 0-13, 14-17, 18-24, more than 25 indicate no anxiety, mild anxiety, moderate anxiety, and severe anxiety, respectively.

The Arabic version of the Tinnitus Handicap Inventory (THI):

We utilized the validated Arabic version of the Tinnitus Handicap Inventory (THI)[17] as a subjective tool to assess the severity of tinnitus and its impact on the quality of life of patients with tinnitus. It consists of 25-items subdivided into functional, emotional, and catastrophic subscales with the total scores ranging from 0 to 100. It reflects the psychological, social, and functional symptoms. Each item can be answered by yes (scored as 4), sometimes (scored as 2), or no (scored as 0). Scores of 0 -16, 18-36, 38-56, 58-76, and 78-100 indicate light or no handicap, mild handicap, moderate handicap, severe handicap, and catastrophic handicap, respectively.

Tinnitus Loudness measurement:

The tinnitus Loudness in group III was determined by presenting a pure tone or noise based on the patients' accounts of their tinnitus characteristics. The patient was asked to raise his hand when the sound was like his tinnitus. At the frequency indicated by the patient, the stimulus was presented ten dBHL below the hearing threshold. We increased the intensity of the signal by 2dBHL each step. We asked the patient to raise his hand when the signal intensity was like his tinnitus. The loudness of tinnitus was reported in the dB Sensation Level.[18]

Hematological examination:

We have taken blood samples from all subjects for Complete Blood Count (CBC). Blood samples were taken three months after complete recovery from COVID-19 in group II and group III. We used a simple ratio between the absolute neutrophil count and the absolute lymphocyte count to calculate the neutrophil-lymphocyte ratio (NLR). We used a simple ratio between the absolute platelet count and the absolute lymphocyte count to calculate the platelet-lymphocyte ratio (PLR). We analyzed all the laboratory data and compared it between the groups.

STATISTICS:

Data were analyzed using Statistical Program for Social Science (SPSS) version 20. Quantitative data were expressed as mean ± standard deviation (SD). We used the ANOVA and Post Hock tests to compare between groups.

The Pearson correlation test to detect whether there was a correlation between the tinnitus handicap inventory with the HAM-A scale, and between the inflammatory markers (NLR, PLR) with each of the tinnitus handicap inventory, the HAM-A scale, and tinnitus loudness. *P values* of less than 0.05 were considered statistically significant.

RESULTS:

Our study included 120 subjects; whose ages ranged from 18 to 45 years who were divided into three groups. The control group consisted of forty healthy individuals (18 males, 22 females). Group II and group III included 80 patients who had a history of covid-19 infection in the previous year (9.88 ± 5.52 months). Group II comprised 40 subjects (21 males, 19 females) who had no otological complaints after COVID infection. While forty patients in the group III (22 males, 18 females) developed bilateral tinnitus during or shortly after COVID-19 infection. All the participants had normal peripheral hearing bilaterally. The average PTA threshold in groups I, II, III was 10.41 ± 4.18, 11.23 ± 5.13, and 12.5 ± 3.67, respectively. Otologic examination and immittancemetry revealed that all the individuals had normal middle ear function. Age and sex were matched between the control and the study groups, with no significant differences in age and sex between both groups ($p > 0.05$). The age range for group I was 27.57±8.65, for group II it was 29.51±10.07 in group II, and for group III it was 30.2±11.79.

In the tinnitus group (group III), Tinnitus Handicap Inventory (THI) results showed that fifteen, thirteen, ten and two patients had a mild, moderate, severe, and catastrophic handicaps, respectively.

When the HAM-A scale scores were compared between the groups using the ANOVA test, a highly significant difference was found ($P = 0.001$) (Table 1). The tinnitus group (group III) scored higher than the other two groups. Post-hock test showed a significant difference between the tinnitus group (group III) and the other groups (group I and group II) ($P2= 0.001$, $P3= 0.001$), but there was no significant difference between group I and group II ($P1=0.327$) (Table 1). Seven patients (17.5%) in group I had an anxiety score greater than 13, while thirteen patients (32.5 %) in group II had an anxiety score greater than 13. In the tinnitus group (group III), thirty-five patients (87.5%) showed an anxiety score of more than 13 [3 (7.5%) patients with mild anxiety, 13 (32.5%) patients with moderate anxiety, and 19 (47.5%) patients with severe anxiety].

Comparing the Platelet- lymphocyte and neutrophil-lymphocyte ratios between the control and the two study groups revealed that the tinnitus group (group III) showed statistically significant higher scores than group I and group II ($P= 0.010$ for Platelet- lymphocyte ratio and $P=0.002$ for neutrophil-lymphocyte ratios) (Table 1). As regards the Platelet- lymphocyte ratio, post hock test revealed a significant difference between the tinnitus group (group III) and both the control group (group I) and the group II ($P2=0.005, P3=0.015$), while there was no significant difference between group I and group II ($P1=0.715$). Post hock test demonstrated that there was a significant difference in neutrophil-lymphocyte ratios between the tinnitus group III and both the control group I and the study group II ($P2=0.001, P3=0.005$), but there was no significant difference between group I and group II ($P1=0.685$) (Table 1).

In the tinnitus group (group III), there was a significant positive correlation between THI and HAM-A (r=0.485, $P= 0.002$) (Figure 1). There was a significant positive correlation between the inflammatory markers (NLR, PLR) and THI (Table 2, Figure 2), HAM-A, and tinnitus loudness as shown in Table (2).

Table 1: Comparison between Hamilton anxiety (HAM-A) scale, platelet to lymphocyte ratio (PLR) and neutrophil to lymphocyte ratio (NLR) between the three groups

		Range			Mean	±	S. D	F. test	*p. value*		Post Hock
HAMA	G I	3	–	18	9.23	±	3.95	76.160	0.001*	P1	0.327
	G II	3	–	19	10.78	±	3.91			P2	0.001**
	G III	9	–	50	26.78	±	10.85			P3	0.001**
PLT / Lymph ratio	G I	55.12	–	140.25	102.79	±	22.75	4.773	0.010*	P1	0.715
	G II	56.06	–	143.18	104.71	±	22.11			P2	0.005*
	G III	70	–	175	117.69	±	25.42			P3	0.015*
Neut / Lymph ratio	G I	1	–	1.92	1.56	±	0.26	6.381	0.002*	P1	0.685
	G II	1.15	–	1.95	1.60	±	0.24			P2	0.001**
	G III	1.03	–	2.81	1.84	±	0.55			P3	0.005*

*significant $P\leq0.05$, **highly significant $P<0.01$
P1: G I & G II
P2: G I & G III
P3: G II & G III

Table 2: Correlation between platelet to lymphocyte ratio (PLR), neutrophil to lymphocyte ratio (NLR) and each of HAM-A and tinnitus loudness and THI

	PLT / Lymph ratio		Neut / Lymph ratio	
	r	*P value*	r	*P value*
HAMA	0.494	0.001*	0.386	0.014*
Loudness	0.514	0.001*	0.436	0.005*
THI	0.439	0.005*	0.389	0.013*

*significant *P≤0.05*, **highly significant *P<0.01*

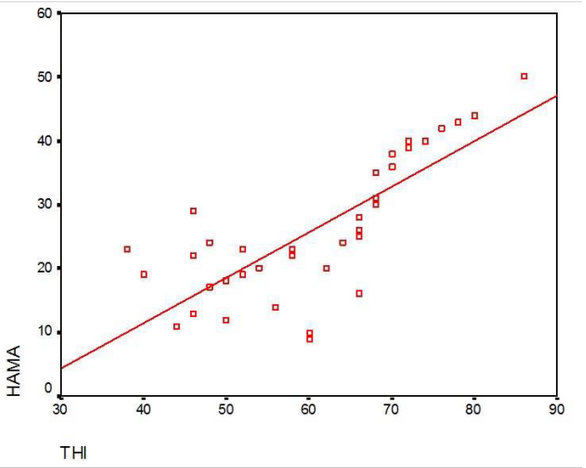

Fig. 1: Correlation between Tinnitus Handicap Inventory (THI) and Hamilton Anxiety (HAM-A) Scales in tinnitus group (Group III).

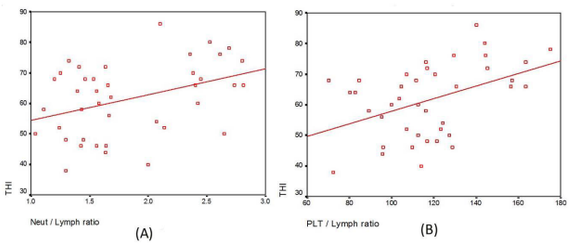

Fig. 2: (A) Correlation between Tinnitus Handicap Inventory (THI) and neutrophil-lymphocyte ratio (Neut/Lymph). (B) Correlation between Tinnitus Handicap Inventory (THI) and platelet-lymphocyte ratio (PLT/Lymph).

DISCUSSION

Tinnitus is the perception of sound without the presence of external acoustic impulses, which can be caused by several medical disorders.[19] About 30% of the patients with tinnitus have normal peripheral hearing with no detectable local or systemic causes. It had been suggested that tinnitus may be linked with anxiety and stress with associated increase of the inflammatory markers.[11,20]

Tinnitus may cause anxiety and stress to the affected patients with subsequent disturbance of their quality of life including e.g., sleep, reading, work and social interactions.[21] As well as it can cause significant emotional (include irritation, annoyance, anxiety, and depression) and somatic distress (headache, neck pain and jaw pain).[22]

The causal relationship between the tinnitus and anxiety is not yet fully understood. It is unclear whether patients report higher levels of symptoms of tinnitus because of the anxiety, or the effects of tinnitus on the quality of life contribute to anxiety.

In this regard, two related systems are implicated in tinnitus: (1) the hypothalamic–pituitary–adrenal axis, which is the main neuroendocrine system that plays an important role in stress response, and (2) the limbic system comprising the hippocampus and amygdala, that adjusts the perception of tinnitus and the adaptation. While the results of prior studies have suggested the possible role of emotional factors in tinnitus through those systems, the correlation was mostly studied in animal models, or in cross-sectional comparisons focusing to establish a connection, rather than on the causality and the directional nature of the link.[23]

It has been reported that patients may develop hearing loss associated with tinnitus after COVID-19 infection but it was also reported that some cases developed tinnitus without affection of hearing.[13,14]

According to the American Tinnitus Association, there was a significantly increased anxiety in the tinnitus patients in 2020 which was unquestionably related to the COVID-19 pandemic, which might be a result of multiple stresses suffered by the individuals and how the lockdown was impacting their way of life through frustration, inadequate supplies, and financial loss.[23] Tinnitus commonly increases or even begins during stressful times.[19] Furthermore, due to the pandemic, receiving healthcare for diseases that are

not considered life-threatening, such as tinnitus, has become increasingly difficult. Because of the evident association between emotional distress and severe tinnitus, the pandemic has been proven to increase fear and worry in the general population and may potentially enhance tinnitus levels. Patients during the pandemic reported poorer sleep quality, more difficulty sleeping, more waking up during the night, and being less refreshed, that were linked to worsening tinnitus.[24,25]

What is clear, however, is that anxiety is quite common in patients with tinnitus. Among 40 patients with tinnitus after COVID-19 infection included in our study, Hamilton anxiety (HAM-A) scale showed that there were 35 patients (87.5%) with an anxiety score more than 13 [3 patients with mild anxiety (scoring 14-17), 13 patients with moderate anxiety (scoring from 18-24) and 19 patients with severe anxiety (scoring more than 25)]. In our study, the degree of affection of the quality of life in the tinnitus patients was assessed by tinnitus handicap inventory that showed a positive correlation with degree of anxiety assessed by the HAM-A scale. In addition, there was a positive correlation between the duration of tinnitus and both THI and HAM-A.

In the current literature, there are several articles correlating the tinnitus with anxiety and stress. In a study conducted by Kim *et al*. (2014)[26] including 344 patients with tinnitus and 87 normal controls, they evaluated the diagnostic and clinical value of several stress hormones (e.g norepinephrine, epinephrine, a metabolite of serotonin, and cortisol). They concluded that blood levels of these stress hormones especially blood serotonin level had diagnostic and clinical values in patients with tinnitus.

Gomaa *et al*. (2014)[27] evaluated co-morbid depression, anxiety and stress associated with tinnitus in a study included 196 subjects: 100 patients suffering from subjective tinnitus associated with hearing loss (tinnitus group), 45 patients were suffering from hearing loss only (hearing loss group) and 50 healthy subjects not suffering from tinnitus or hearing loss (control group). They utilized Depression, Anxiety and Stress Scale (DASS) to measure the negative emotional status of depression, anxiety, and stress. They concluded that the duration of tinnitus correlated with the severity of depression and stress, and recommended that depression, anxiety, and stress should be taken into consideration in the treatment of patients suffering from tinnitus.

In our study, there was statistically significant difference between the control and tinnitus group as regards of the inflammatory markers (NLR and PLR). These results agreed with Ozbay *et al*. (2015)[11] who showed significantly higher NLR and PLR in patients with tinnitus in comparison to the control subjects. However, our results did not agree with Ulusoy *et al*. (2018)[28], as there was no significant difference between the patients with tinnitus and the control group as regards of neutrophil to lymphocyte ratio and platelet to lymphocyte ratio.

Our study demonstrated that there was statistically significant positive correlation between Tinnitus Handicap Inventory (THI) and both NLR and PLR. As well as there was significant positive correlation between tinnitus loudness and NLR and PLR.

To our knowledge, our study is the first prospective one that utilized objective (inflammatory markers) and subjective findings (two validated quality of life questionnaires, and tinnitus loudness) to describe the relationship between the tinnitus, anxiety, and stress during the COVID-19 pandemic. We found that there was a strong correlation between the tinnitus and anxiety associated with elevated inflammatory markers.

One limitation of our study is that the data were collected only from one center, so further information from other centers would be helpful to validate our results. Another limitation is that our study focused on establishing a correlation between the tinnitus and anxiety, rather than on the causality and the directional nature of this correlation.

CONCLUSION

Anxiety and stress associated with COVID-19 infection may cause tinnitus in some patients.

RECOMMENDATION

The physicians should take into consideration the importance of anxiety factor in the diagnosis and management of patients with idiopathic tinnitus following COVID-19 infection.

CONFLICT OF INTEREST

There are no conflicts of interest.

REFERENCES

1. Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, *et al*. World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19). Int J Surg 2020;76:71–6. doi: 10.1016/j.ijsu.2020.02.034

2. Tian S, Hu N, Lou J, Chen K, Kang X, Xiang Z, Chen H, Wang D, Liu N, Liu D, Chen G, Zhang Y, Li D, Li J, Lian H, Niu S, Zhang L, Zhang J. Characteristics of COVID-19 infection in Beijing. J Infect 2020; 80(4):401–406. https://doi.org/10.1016/j. jinf.2020.02.018

3. Shuja KH, Aqeel M, Jaffar A, Ahmed A. COVID-19 Pandemic and Impending Global Mental Health Implications. Psychiat Danub 2020; 2(1):32-5.

4. Yang Y, Peng F, Wang R *et al*. The deadly coronaviruses: The 2003 SARS pandemic and the 2020 novel coronavirus epidemic in China. J autoimmun 2020; 109:102434.

5. Anderson RM, Heesterbeek H, Klinkenberg D *et al*. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet Psychiat 2020; 395(10228):931-4.

6. 6- Lewnard JA, Lo NC. Scientific and ethical basis for social-distancing interventions against COVID-19. Lancet Infect Dis 2020; 20:631. doi:10.1016/S1473-3099(20)30190-0

7. Hoffman HJ, Reed GW. Epidemiology of tinnitus. In: Snow JB, ed. Tinnitus: Theory and Management. Hamilton, Ontario: BC Decker, 2004;16–41.

8. Zirke N, Seydel C, Arsoy D *et al*. Analysis of mental disorders in tinnitus patients performed with Composite International Diagnostic Interview. Qual Life Res 2013; 22:2095–2104.

9. Salviati M, Bersani FS, Terlizzi S *et al*. Tinnitus: clinical experience of the psychosomatic connection. Neuropsychiatr Dis Treat 2014; 10:267–275.

10. Sahlsten H, Taiminen T, Karukivi M. Psychiatric (Axis I) and personality (Axis II) disorders and subjective psychiatric symptoms in chronic tinnitus. Int J Audiol 2018; 57:302–312.

11. Ozbay I, Kahraman C, Balikci HH *et al*. Neutrophil-tolymphocyte ratio in patients with severe tinnitus: prospective, controlled clinical study. J Laryngol Otol 2015; 129:544–547.

12. Costello H, Gould RL, Abrol E *et al*. Systematic review and meta-analysis of the association between peripheral inflammatory cytokines and generalised anxiety disorder. BMJ Open 2019;9(7):e027925.

13. Elibol E. Otolaryngological symptoms in COVID-19. Eur Arch Otorhinolaryngol 2020; 1:1-4.

14. Ozcelik KM, Egilmez OK, Ozcelik MA, Guven M. Otolaryngological manifestations of hospitalised patients with confirmed COVID-19 infection. Eur Arch Otorhinolaryngol 2020; 278:1675–1685.

15. American Speech-Language-Hearing Association. Manual pure-tone threshold audiometry –ASHA 1978;20(4):297-301.

16. Hallit S, Haddada C, Hallita R *et al*. Validation of the Hamilton Anxiety Rating Scale and State Trait Anxiety Inventory A and B in Arabic among the Lebanese population. CEGH 2019;464–470.

17. Barake R, Rizk SA, Ziade G *et al*. Adaptation of the Arabic Version of the Tinnitus Handicap Inventory. Otolaryngol Head Neck Surg 2016;154:508-12.

18. Vernon JA, Meikle MB. Tinnitus: Clinical measurement. Otolaryngol. Clin N Am 2003;36:293-305.

19. Mazurek B, Haupt H, Olze H *et al*. Stress and tinnitus from bedside to bench and back. Front Syst Neurosci 2012; 6: 47. doi:10.3389/fnsys.2012.00047

20. Crummer RW, Hassan GA. Diagnostic approach to tinnitus .Am Fam Physician 2019; 69(1):120–126.

21. Meikle MB, Vernon J, Johnson RM. The perceived severity of tinnitus. Otolaryngol Head Neck Surg 1981; (92):689–96.

22. Hébert S, Canlon B, Hasson D *et al*. Tinnitus severity is reduced with reduction of depressive mood a prospective population study in Sweden. PLoS One 2012; 7(5):377-33.

23. Xia L, He G, Feng Y *et al*. COVID-19 associated anxiety enhances tinnitus. PLoS One. 2021;16(2):e0246328.

24. Mertens G, Gerritsen L, Duijndam S, Salemink E, Engelhard I. Fear of the coronavirus (COVID-19): predictors in an online study conducted in March 2020. J Anxiety Disord 2020; 74:102258. doi: 10.1016/j.janxdis.2020.

25. Mazurek B, Boecking B, Brueggemann P. Association between stress and tinnitus new aspects. Otol Neurotol 2019;40:e467–73. doi:10.1097/MAO.0000000000002180.

26. Kim DK, Chung DY, Bae SC *et al*. Diagnostic value and clinical significance of stress hormones in patients with tinnitus. Eur Arch Otorhinolaryngol 2014; 271:2915–21

27. Gomaa MA, Elmagd MH, Elbadry MM *et al*. Depression, Anxiety and Stress Scale in patients with tinnitus and hearing loss. Eur Arch Otorhinolaryngol 2014;271:2177–84.

28. Ulusoy B, Bozdemir K, Akyol M *et al*. Investigation of neutrophil-to-lymphocyte ratio, platelet-to-lymphocyte ratio and mean platelet volume in patients with tinnitus.J Laryngol Otol 2018;132(2):129-132.