J Surg Med. 2022;6(2):158-161.
DOI: 10.28982/josam.1056873

Journal of Surgery and Medicine
e-ISSN=2602-2079

Evaluation of stress and cognitive skills in individuals with tinnitus complaints

Nuriye Yıldırım Gökay, Bilgehan Tekin Dal

Department of Audiology, Faculty of Health Sciences, Gazi University, Ankara, Turkey

ORCID ID of the author(s)
NYG: 0000-0003-2161-6579
BTD: 0000-0001-6140-244X

Corresponding Author
Bilgehan Tekin Dal
Emek Mah. Bişkek Cad. 6. Cad. (eski 81. sokak) No:2 06490, Çankaya, Ankara, Turkey
E-mail: bilgehantd@gmail.com

Ethics Committee Approval
The study protocol was approved by Gazi University Ethics Committee (with the approval number: E-77082166-604.01.02-262593). All procedures in this study involving human participants were performed in accordance with the 1964 Helsinki Declaration and its later amendments.

Conflict of Interest
No conflict of interest was declared by the authors.

Financial Disclosure
The authors declared that this study has received no financial support.

Published
2022 February 6

Abstract

Background/Aim: The sense of sound in the absence of external acoustic stimuli is known as subjective tinnitus, or phantom tinnitus. The purpose of this study was whether tinnitus complaints have an impact on perceived stress and cognitive skills like attention and memory.

Methods: This prospective case-control study comprised 60 healthy volunteers between the ages of 18 and 25, all of whom had normal hearing. Using the G*Power program, it was established that a minimum of 50 people should be worked with an 80 percent power and a 5% margin of error. The study group consisted of 30 people with tinnitus complaints in their daily lives, whereas the control group consisted of the remaining people. Tinnitus Handicap Inventory and Perceived Stress Scale were applied to the participants within the scope of the working hypotheses. In terms of cognitive skills, the Stroop Test Form was applied to evaluate selective attention, focused attention and disruptive effects, and the Visual Auditory Digit Sequence Test Form was applied to evaluate short-term memory and working memory skills. The findings were analyzed with the SPSS program. Type 1 error level is determined as 5%.

Results: According to Tinnitus Handicap Inventory, tinnitus complaint of all individuals in the study group is very mild. The statistically significant differences were found between the perceived stress level, Stroop and Visual Auditory Digit Sequence Test scores between people with and without tinnitus complaints. The poorer performance was observed in the group with tinnitus complaint. (P=0.037, P=0.017, P=0.010). No statistically significant relationship was found between perceived stress level, tinnitus and cognitive skills (P=0.067, P=0.160, P=0.208).

Conclusion: Tinnitus is becoming a more common cause of health problems, sometimes coupled by psychological stress, and it affects cognitive skills. The study adds to the knowledge regarding the use of cognitive tests as a supplemental measurement in the evaluation of tinnitus and the impact of tinnitus on daily cognitive abilities.

Keywords: Tinnitus, Cognition, Stress

How to cite: Yıldırım Gökay N, Tekin Dal B. Evaluation of stress and cognitive skills in individuals with tinnitus complaints. J Surg Med. 2022;6(2):158-161.

Introduction

Subjective tinnitus, or phantom tinnitus, is the perception of sound in the absence of external acoustic stimulation [1]. Individuals with tinnitus account for around 12% to 30% of the population, with 1% to 3% of the population suffering seriously from the illness [2]. Tinnitus is most commonly associated with damage to the peripheral auditory system, which results in abnormal plasticity of the auditory pathway [3].

Tinnitus' connections with other clinical manifestations, particularly emotional aspects including depression, anxiety, and stress, have been thoroughly researched. Tinnitus is strongly linked to neurological causes, according to established evidence [4,5]. Tinnitus Handicap Inventory (THI) categorizes tinnitus severity as very mild, mild, moderate, severe, and very severe [6]. For many years, the association between tinnitus and associated psychological problems has attracted people's interest and been studied. Tinnitus has been shown to have a significant impact on psychological health and lower the quality of life of those who suffer from it [7-9]. Subjective tinnitus is characterized as a common, debilitating hearing impairment that produces considerable emotional stress and psychological distress, according to another study. When people are stressed, their tinnitus gets worse. Hormones linked to biological stress markers were shown to play a crucial function in tinnitus patients in this study. The available data has been shown to definitely support the existence of extensive correlations between tinnitus and psychological stress [10].

The relationship between tinnitus and cognitive skills has also been another focus of researchers. Many studies addressing the association between tinnitus and various cognitive skills such as attention, working memory, executive functions, language ability, and intelligence quotient (IQ) have been found in literature reviews [11, 12]. Psychometric data from 107 people with chronic subjective tinnitus were evaluated in another research. In this study, a significant correlation was found between tinnitus and the performance of selective and sustained attention tasks, similar to earlier investigations. The most important predictor of cognitive performance has been identified as the tinnitus problem [13]. In a study focusing on the relationship between stress and tinnitus, it was stated that this relationship remained causal and directionally uncertain [14]. Tinnitus, according to another study, has a unique impact on cognitive performance, particularly general or crystallized intelligence and executive skills. It has been suggested that more research on the relationship between tinnitus complaint and cognitive skills required for daily functioning is needed [15].

Although there are many studies in the literature on cognitive skills and stress in individuals with tinnitus, there are limited studies close to the current working hypotheses. While the findings of the reviewed correlational research demonstrate that tinnitus reduces cognitive performance in terms of attention and executive functions, there have also been reports of invalid or opposite findings. The main aim of the current study is to investigate whether tinnitus complaints have effects on perceived stress and cognitive skills such as attention and memory in individuals aged 18-25 years with normal hearing.

The current study focuses on the various effects and correlational analyses on cognition in people with tinnitus complaints, as well as the differences between them and healthy controls.

While some earlier studies have reported initial report on tinnitus stress and cognitive skills, our investigation, with its unique study design and assessment methods, would make a significant contribution to the literature. In addition, it is aimed to reveal the importance of cognitive tests in the evaluation of tinnitus and to raise awareness about stress and cognitive problems associated with tinnitus.

Materials and methods

This study was approved by Gazi University Ethics Committee with an approval number of E-77082166-604.01.02-262593. The informed consent forms were obtained from each of the volunteer participants in the study. The study was conducted per the principles of the Helsinki declaration.

The study comprised 60 people between the ages of 18 and 25 who had normal hearing. The study group consisted of 30 people with tinnitus complaints in their daily lives, whereas the control group consisted of the remaining people. Individuals with additional disabilities, such as a history of ear infection or surgery, noise exposure, use of ototoxic medications, active middle ear pathology, neurological problems, and so on, were excluded from the study.

The Perceived Stress Scale was applied to all volunteers in the study to assess their stress levels in daily life [16]. In terms of cognitive skills, the Stroop Test Form was applied to evaluate selective attention, focused attention and disruptive effects, and the Visual Auditory Digit Sequence Test Form (VADS) was applied to assess the short-term memory and working memory skills. Tinnitus Handicap Inventory was applied to individuals who reported that they had tinnitus complaints.

The Perceived Stress Scale is a 14-question test that ranges from 1 (never) to 5 (always) scores. A maximum score of 70 is given, and high scores indicate a high level of stress, according to the questions.

The Stroop Test Form indicates the ability to modify perceptual setup in response to changing demands, as well as the ability to suppress a regular behavior pattern and conduct an unexpected activity under a "disruptive effect" [17]. In this test, participants are asked to say the color of the color names printed in different colors, not what they write. In the meantime, the time to complete the test, the number of corrections and errors are determined.

The VADS is a test developed by Koppitz [18] that measures short-term memory (SSD) capacity. The person is expected to repeat the digits he or she hears or sees in this test. The number of the longest recalled sequence of the test is stated in the "Score" section of the form.

The THI was applied to the volunteer participants with tinnitus complaints. This test consists of 25 questions about the characteristics of tinnitus and its effects on life. The answers such as Yes, No, Sometimes are recorded. The scale score is calculated by multiplying the number of Yes answers with 4 points, Sometimes the number of answers with 2 points, and the number of No answers with 0 points [19].

Statistical analysis

Statistical Package for Social Sciences (SPSS) version 25 was used for statistical analyses. The variables were investigated using visual (histogram and probability plots) and analytical methods (Kolmogorov-Smirnov/ Shapiro Wilk's test) to determine whether or not they are normally distributed. Descriptive analyses were presented using mean and standard deviation for normally distributed variables and the p values result from the Independent Samples t-test in the groups which demonstrated normal distribution. The relationship between stress score, tinnitus level, Stroop test time and VADS score were evaluated by Pearson regression analysis. Type 1 error level is determined as 5%.

Results

The participants' mean age was 19.27 (1.57) years in the study group and 20.07 (2.05) years in the control group who did not have tinnitus complaints. While 18 of the 30 individuals in the study group were females and 12 were males, there were 14 females and 16 males in the control group (Table 1). There was no statistically significant difference between the two groups in terms of age and gender (P=0.095).

Table 1: Descriptive data of participants

	Gender		Age (years)
	Male	Female	Mean (SD)
The study group	12 (40%)	18 (60%)	19.27 (1.57)
The control group	16 (53.3%)	14 (46.7%)	20.07 (2.05)

SD: Standard deviation

The participants with tinnitus complaints in the study group received an average THI score of 11.90 (2.86). As a matter of fact, these values reveal that all participants in the study group have a very mild tinnitus problem. According to the Perceived Stress Scale, the mean scale scores of the participants in the study and control groups were 44.80 (3.32) and 43.10 (3.11), respectively.

The Stroop Test and the VADS test scores evaluating neuropsychological performance are presented in detail in Table 2. The mean completion time of the Stroop test in the study group was 20.73 (2.05) seconds, the mean VADS auditory-verbal response score was 8.77 (0.86), and the VADS visual-verbal response score was 8.03 (0.72) on average. These scores were 19.51 (2.36) seconds, 9.37 (1.03), and 8.63 (1.00) in the control group without tinnitus complaints, respectively.

Table 2: The findings of the stroop test and the VADS test

	Study group Mean (SD)	Control group Mean (SD)	*P*-value
Stroop time (sec)	20.73 (2.05)	19.51 (2.36)	0.037*
VADS auditory	8.77 (0.86)	9.37 (1.03)	0.017*
VADS visual	8.03 (0.72)	8.63 (1.00)	0.010*

SD: Standard deviation VADS: Visual Auditory Digit Sequence

In the Stroop Test, 9 people in the study group and 3 people in the control group made correction only once.

A statistically significant difference was found between the study and control groups in terms of the Perceived Stress Scale score (P=0.045). In terms of Stroop Test completion time, a statistically significant difference was detected between the study and control groups (P=0.037). The statistically significant differences were found between the two groups in terms of VADS visual-verbal response and auditory-verbal response scores (respectively P=0.010 and P=0.017).

No statistically significant correlation was found between the Tinnitus Handicap Inventory score and the Perceived Stress Scale score (P=0.274).

Similarly, no statistically significant correlation was found between the Perceived Stress Scale score and the findings of the Stroop test and the VADS test (Table 3).

Table 3: The correlation findings of perceived stress scale score, the stroop test and the VADS test

The Perceived Stress Scale	Pearson Correlation	*P*-value
Stroop time (sec)	0.029	0.829
VADS auditory	-0.009	0.944
VADS visual	-0.163	0.214

VADS: Visual Auditory Digit Sequence

The Tinnitus Handicap Inventory score, the Stroop test, and the VADS scores had no statistically significant correlation (Table 4).

Table 4: The correlation findings of tinnitus handicap inventory score, the stroop test and the VADS test

Tinnitus Handicap Inventory score	Pearson Correlation	*P*-value
Stroop time (sec)	0.338	0.067
VADS auditory	-0.263	0.160
VADS visual	-0.237	0.208

VADS: Visual Auditory Digit Sequence

Discussion

Tinnitus is an auditory symptom resulting from psychological distress, high levels of anxiety, and depression symptoms. The people with stress-related tinnitus complaints have a variety of problems, including insomnia, bad quality of life, lack of attention, susceptibility to stress, and irritability. According to the findings of the current study, the significant difference between the Perceived Stress Scale scores between the tinnitus complaining group and the control group is consistent with this relationship. Previous studies in both animals and humans have looked into the impact of stress on the auditory system. As a result, the stress has an effect on mineral and glucocorticoid receptors in the inner ear [21]. Similarly, when stress was eliminated, corticosterone levels increased, offering a protective mechanism against noise-induced hearing loss [22]. Similarly, Mazurek et al. reported that regularly occurring psychological stress causes significant impairments in evoked auditory potentials and an increase in the expression of inflammation genes in the inferior colliculus [23, 24].

Although this causal relationship between tinnitus and stress has been the focus of research, it has been limited to anecdotal and clinical observations. Nonetheless, evidence from these researches suggests that there is an indirect relationship between stress and the clinical course of tinnitus. The people with sudden hearing loss and tinnitus have been reported to experience more stressful events in their lives, as well as poorer coping abilities, compared to other clinical groups [5, 13, 25]. Subjective anxiety, perceived stress, and tinnitus discomfort were shown to reduce in tinnitus patients after a stress-reduction therapy program [26]. The functional and electroencephalographic neuroimaging studies in tinnitus patients have shown abnormal connections between the limbic system and auditory system structures [27]. From this point of view, although the participants in our study had normal audiograms, the presence of tinnitus complaint may be due to the disorder in these connections with the limbic system. On the other hand, the absence of a significant relationship between the Perceived Stress Scale score and THI score in the current

correlation analyzes may be due to the small sample size. Since it has been noticed that the participants in the study commonly experience conditions such as exam stress and employment anxiety between the ages of 18 and 25, the stress scale scores are expected to be high.

Another topic that experts in this discipline are interested in is the relationship between tinnitus and cognitive abilities. Tinnitus has been shown to negatively affect attention, cognitive processing, and memory in studies combining neurophysiological tests, neuroimaging techniques, and behavioral tests of cognitive performance [11, 12, 17, 28]. Similarly, in the current study, the group with tinnitus had a significantly lower performance in selective attention, interference, focusing ability, working memory and short-term memory skills evaluated with the Stroop test and the VADS. It has been suggested that the possible reason for this finding is that tinnitus affects executive control of attention and impairs cognitive functions [12]. At the same time, cognitive performance may be negatively affected by adding anxiety and depression to tinnitus. On the other hand, although tinnitus patients had delayed P300 responses, behavioral responses were found to be within normal limits in cognitive tests [29]. There was no significant correlation between the Stroop test and the VADS test scores in our current study, and THI score Gabr et al. [29] can be explained as in his work. Similar to the literature, in the current study, it was reported that anxiety, depression and somatic sensitivity levels, which are responsible for many variables, have an effect on executive control of attention. People with tinnitus complaints need more attention resources [15].

Limitations

The inclusion of participants with very mild tinnitus levels may be among the limitations of the study.

Conclusion

Tinnitus is becoming a more common cause of health problems, sometimes coupled by psychological stress, and it affects people from all walks of life. Although many causes of tinnitus are unavoidable, psychological stress can be managed with professional help and a therapeutic approach. The negative effects of tinnitus on cognitive skills can also be diagnosed and prevented by multidisciplinary approach. Therefore, close cooperation of audiologists, psychiatrists, psychologists, psychotherapists and neurologists is important for the effective treatment of these people.

The current study, on the other hand, creates awareness about the use of cognitive tests as a supplemental measurement in the evaluation of tinnitus and the disruptive effect of tinnitus on daily cognitive skills. As in this study, investigating the relationship between tinnitus and cognitive skills can guide the therapy treatment methods to be more comprehensive and competent. The future studies with large sample groups and detailed assessment tools on tinnitus, cognitive skills and stress are needed.

References

1. Haider HF, Bojić T, Ribeiro SF, Paço J, Hall DA, Szczepek AJ. Pathophysiology of subjective tinnitus: triggers and maintenance. Front Neurosci. 2018;12:866.
2. McCormack A, Edmondson-Jones M, Somerset S, Hall D. A systematic review of the reporting of tinnitus prevalence and severity. Hear Res. 2016;337:70-9.
3. Jastreboff PJ. Phantom auditory perception (tinnitus): mechanisms of generation and perception. Neurosci Res. 1990;8(4):221-54.
4. Langguth B, Landgrebe M, Kleinjung T, Sand GP, Hajak G. Tinnitus and depression. World J Biol Psychiatry. 2011;12(7):489-500.
5. Mazurek B, Szczepek A, Hebert S. Stress and tinnitus. HNO. 2015;63(4):258-65.
6. Newman CW, Jacobson GP, Spitzer JB. Development of the tinnitus handicap inventory. Arch Otolaryngol Head Neck Surg. 1996;122(2):143-8.
7. Andersson G. Psychological aspects of tinnitus and the application of cognitive–behavioral therapy. Clin Psychol Rev. 2002;22(7):977-90.
8. Erlandsson SI, Hallberg LR. Prediction of quality of life in patients with tinnitus. Br J Audiol. 2000;34(1):11-9.
9. Kennedy V, Wilson C, Stephens D. Quality of life and tinnitus. Audiological Med. 2004;2(1):29-40.
10. Pupić-Bakrač J, Pupić-Bakrač A. Comorbidity of Chronic Tinnitus and Psychological Stress-Which Came First, the Chicken or the Egg? Psychiatr Danub. 2020;32(suppl. 4):412-9.
11. Mohamad N, Hoare DJ, Hall DA. The consequences of tinnitus and tinnitus severity on cognition: a review of the behavioural evidence. Hear Res. 2016;332:199-209.
12. Tegg-Quinn S, Bennett RJ, Eikelboom RH, Baguley DM. The impact of tinnitus upon cognition in adults: A systematic review. Int J Audiol. 2016;55(10):533-40.
13. Brueggemann P, Neff PK, Meyer M, Riemer N, Rose M, Mazurek B. On the relationship between tinnitus distress, cognitive performance and aging. Prog Brain Res. 2021;262:263-85.
14. Mazurek B, Boecking B, Brueggemann P. Association between stress and tinnitus—new aspects. Otol Neurotol. 2019;40(4):e467-e73.
15. Neff P, Simões J, Psatha S, Nyamaa A, Boecking B, Rausch L, et al. The impact of tinnitus distress on cognition. Sci Rep. 2021;11(1):1-9.
16. Kaya C, Tansey TN, Melekoglu M, Cakiroglu O, Chan F. Psychometric evaluation of Turkish version of the Perceived Stress Scale with Turkish college students. J Ment Health. 2019;28(2):161-7.
17. Homack S, Riccio CA. A meta-analysis of the sensitivity and specificity of the Stroop Color and Word Test with children. Arch Clin Neuropsychol. 2004;19(6):725-43.
18. Koppitz EM. The visual aural digit span test for seventh graders: a normative study. J Learn Disabil. 1981;14(2):93-5.
19. Aksoy S, Firat Y, Alpar R. The Tinnitus Handicap Inventory: a study of validity and reliability. Int Tinnitus J. 2007;13(2):94-8.
20. Bamiou D-E, Campbell P, Liasis A, Page J, Sirimanna T, Boyd S, et al. Audiometric abnormalities in children with Gaucher disease type 3. Neuropediatrics. 2001;32(03):136-41.
21. ten Cate WJ, Curtis LM, Rarey KE. Immunochemical detection of glucocorticoid receptors within rat cochlear and vestibular tissues. Hear Res. 1992;60(2):199-204.
22. Horner K. The emotional ear in stress. Neurosci Biobehav Rev. 2003;27(5):437-46.
23. Mazurek B, Haupt H, Joachim R, Klapp BF, Stöver T, Szczepek AJ. Stress induces transient auditory hypersensitivity in rats. Hear Res. 2010;259(1-2):55-63.
24. Mazurek B, Haupt H, Klapp BF, Szczepek AJ, Olze H. Exposure of Wistar rats to 24-h psycho-social stress alters gene expression in the inferior colliculus. Neurosci Biobehav Rev. 2012;527(1):40-5.
25. Fagelson MA. The association between tinnitus and posttraumatic stress disorder. Am J Audiol. 2007; 16(2):107-17.
26. Elarbed A, Fackrell K, Baguley DM, Hoare DJ. Tinnitus and stress in adults: a scoping review. Int J Audiol. 2021;60(3):171-82.
27. Kraus KS, Canlon B. Neuronal connectivity and interactions between the auditory and limbic systems. Effects of noise and tinnitus. Hear Res. 2012;288(1-2):34-46.
28. Rossiter S, Stevens C, Walker G. Tinnitus and its effect on working memory and attention. J Speech Lang Hear Res. 2006;49(1):150-60.
29. Gabr TA, Abd El-Hay M, Badawy A. Electrophysiological and psychological studies in tinnitus Auris Nasus Larynx. 2011;38(6):678-83.

This paper has been checked for language accuracy by JOSAM editors.
The National Library of Medicine (NLM) citation style guide has been used in this paper.