Analysis on Risk Factors of Depressive Symptoms in Occupational Noise-induced Hearing Loss Patients: A Cross-sectional Study

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Abstract

Objective: The aim of this study was to evaluate the risk factors of depressive symptoms in occupational noise-induced hearing loss (NIHL) patients. Methods: A total of 106 patients were divided into depressive symptoms (ONHLPD) and without depressive symptoms (non-ONHLPD) according to the Self-rating Depression Scale. Questionnaires and laboratory data were collected and analyzed. Data were analyzed with independent t-test, Wilcoxon test, Pearson correlation analysis and multiple linear regression models. Results: The prevalence of depressive symptoms was 53.8% in occupational NIHL patients. In ONHLPD, duration of the hearing loss, level of serum cortisol, scores of Pittsburgh Sleep Quality Index and Tinnitus Handicap Inventory were all significantly higher than those of non-ONHLPD. Conclusion: The prevalence of depressive symptoms was relatively high in occupational NIHL patients. Duration of the hearing loss, sleep quality and tinnitus severity were the risk factors for occupational NIHL patients with depressive symptoms.

Keywords: Cross-sectional study, depressive symptoms, occupational noise-induced hearing loss, risk factors

INTRODUCTION

Occupational noise-induced hearing loss (NIHL) had been recognized since as early as the 18th century, when it was mentioned that copper miners and blacksmiths suffered from hearing impairment because of continuous exposure to noise.[1] As one of the most prevalent occupational diseases, occupational exposure to continuous high levels of noise causes a great number of hearing loss patients, the Occupational and Environmental Health Unit of World Health Organization reported that 16% of the disabling hearing loss in adults is attributable to occupational noise exposure.[2] In USA, there are more than 22 million US workers are exposed to occupational high level of noise and an estimated $242 million is spent annually on compensation for hearing loss disability.[3] In China, the largest developing country of the world, occupational NIHL has become the third most serious occupational disease with rapid urbanization and industrialization according to data from the National Centers for Disease Control and Prevention.[4] Except for hearing damage caused by noise, evidence of the non-auditory effects of noise exposure on mental health is

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growing. As an important environmental stressor, previous studies revealed that loud noise can induce a variety of symptoms including changes in emotional stress, increase in social conflicts, sleep disturbance, anxiety, depression, as well as general psychiatric disorders.[5-7] In those mental disorders, depression has been identified as the most prevalent mental illness and a leading cause of disability and suicide rates.[8,9] However, clinical studies on the associations between depression and noise have shown conflicting results.[10] Some previous studies revealed that high aircraft noise resulted in both acute and chronic irritability and depressive symptoms in local residents.[11,12] A result from Nationwide Survey of Korea showed that occupational noise annoyance was significantly related to mental health, including depressive symptoms and suicidal ideation.[13] However, another investigation failed to find an association between aircraft noise and psychiatric hospital admission rates after adjusted for socio-demographic variables.[14] Additionally, a prospective research also found no association between mental disorder and traffic noise after controlling for socio-demographic factors.[15]

Besides the conflicting results, studies on the effects of psychological symptoms are often ignored in the process of treatment for patients of occupational NIHL. It is surprising that prevalence and the characteristics of depressive symptoms for patients with occupational NIHL have not been studied before. By using cross-sectional survey, the aim of this study is to estimate the frequency and characteristics of depressive symptoms occurring with patients of occupational NIHL. The patients were divided into ONHLPD and non-ONHLPD according to the depression scale score. The differences between two groups, including patients’ age, gender, educational level, duration of occupational NIHL, noise level, auditory thresholds, years of working, sleep quality, degree of tinnitus and cortisol levels were studied. Furthermore, the differences in these influential factors which contributed to the depressive symptoms in patients with occupational NIHL were also addressed.

**METHODS**

**Participants**

This study was approved by XXX [Blinded by request from JOEM]. All patients were recruited from the inpatient department of Guangdong Provincial Hospital for Occupational Disease Prevention and Treatment from June 2016 to December 2017.

**Inclusion criteria:** (1) Met the diagnosis of occupational NIHL according to Diagnosis of Occupational Noise-induced Deafness (National Occupational Health Standards in People’s Republic of China, GBZ 49—2014)[16]; (2) age ≥18 years; (3) being conscious and have no mental retardation, can cooperate to complete the questionnaire; (4) no history of the use of antidepressant drugs, no alcohol or psychoactive substances dependence; (5) volunteer, good compliance and signed informed consent.

**Exclusion criteria:** (1) History of ototoxic drugs use or other ear diseases that caused deafness; (2) having severe visual impairment or dysgraphia, unable to cooperate and complete the questionnaire; (3) having cancer, hepatic failure, renal failure, diabetes or other serious medical diseases; (4) infection or a history of alcohol intake within the previous week.

**Clinical interviews**

All participants were required to attend a clinical Interview. They were informed of the purpose, procedure and possible benefits and risks of participation in this study. The participants who agreed to join the trial were asked to sign informed consent forms and to provide information on their names, age, gender, nationality, marital status, educational level, previous history including previous medical history, treatments received and current medication. All subjects in this study were also interviewed by an experienced psychiatrist to determine whether the patients met the criteria of depression symptoms. In this study, Zung Self-rating Depression Scale (ZSDS) was applied for the communication obstacle by hearing loss in the process of filling out the scale.

**Zung Self-rating Depression Scale (ZSDS)**

The depression symptoms were measured by adopting the Chinese edition of ZSDS. This scale was designed by William WK Zung for the purpose of evaluating the level of depression in patients who experience depression-related symptoms.[17] In China, this scale has been widely used. It has been confirmed that ZSDS is reliable and valid for the Chinese population.[18,19] The scale contains 20 items, with each is scored on a scale of 1–4 (never, some of the time, relatively often and almost always). The original score range of this scale is from 20 to 80. In addition, higher score represents severer depressive symptoms. In previous studies, depression severity was defined as four categories according to the original score as follows: normal range below 40 points; mild depression 40–47 points; moderate depression 48–55 points; severe depression 56 points and above.[20]

**Tinnitus Handicap Inventory (THI)**

THI was adopted to assess the disability and the amount of distress that tinnitus evoked. THI has been recommended as a research tool for diagnostic purpose or assessment of tinnitus severity. THI Chinese version has good reliability (the split-half reliability is 0.88, test-retest reliability is 0.98 and Cronbach’s α is 0.90).[21] It is comprised of 25 items including functional, emotional and catastrophic subscales. Each item is scored on a scale of 0-2-4 (0 for no, 2 for sometimes, 4 for yes). The score range of this scale is from 0 to 100. There are five degrees of severity for the THI score: 0–16=slight or; 18–36=mild handicap; 38–56 =moderate handicap; 58–76= severe handicap; 58–100=catastrophic handicap.[22]
**Pittsburgh Sleep Quality Index (PSQI)**

PSQI is one of the most validated and widely used questionnaires to measure sleep quality and disturbances during the past month. It has been translated into many languages and widely used in clinical research. The Chinese version of PSQI has an overall reliability coefficient of 0.82–0.83 for all subjects.[23] It consists of 19 self-rated questions measuring seven component scores (with subscales ranged 0–3): (a) subjective sleep quality, (b) sleep latency, (c) sleep duration, (d) habitual sleep efficiency, (e) sleep disturbances, (f) use of sleep medications and (g) daytime dysfunction. The sum of these seven components scores yield one global score of subjective sleep quality (ranged 0–21). Higher scores represent poorer subjective sleep quality. Patients with a PSQI score ≥ 7 are considered sleep-impaired.[24]

**Assessment of the serum cortisol**

After completing scale assessments, all participants were led to the Blood Collection Department and 2 ml elbow vein fasting blood was withdrawn with a single-use arterial blood gas needle in the morning. The serum samples were separated and stored at −80°C until assayed. No sample was stored for longer than 2 weeks. Serum cortisol was measured by electrochemiluminescent immunoassay on a Roche Diagnostics Cobas E602 Analytics Platform (Roche Diagnostics, Indianapolis, USA).

**Pure-tone audiometry**

Pure-tone audiometry has remained the unequivocal gold standard for assessment of hearing as a clinical tool. The pure-tone audiometry for all frequencies was determined by Diagnosis of Occupational Noise-induced Deafness in China, GBZ 49—2014[16] in the audiometric center. The mean hearing level (dB HL) was calculated by averaging all thresholds for both ears measured in PTA from 125 to 8 kHz. Hearing ability was defined according to a speech-frequency pure tone average of thresholds at 0.5, 1, 2 and 4 kHz in the better-hearing ear. Analysis of the hearing impairment severity was based on the grades of hearing impairment which the World Health Organization applies: normal hearing <25.0 dB, mild impairment 26–40 dB, moderate impairment 41–60 dB, severe impairment 61–80 dB, profound impairment ≥81 dB.[25]

**Data Analysis**

Categorical data were presented with cases and constituent rates (n, %) and analyzed with the chi-squared tests (or Fisher’s exact test). After the data normality test, the normally distributed data were presented as means ± standard deviations (X ±SD) and analyzed with independent t-test. The non-normally distributed data were presented as medians and interquartile range [M (P25, p75)] and analyzed with the Wilcoxon test. The relationship between two variables was determined by using Pearson correlation analysis and multiple linear regression models with enter method. Data were analyzed with the SPSS 19.0 (SPSS Inc., Chicago, IL, USA) software package. The significance level was set to P ≤ 0.05.

**RESULTS**

This study consists of 106 patients with occupational NIHL in Guangdong Provincial Hospital for Occupational Disease Prevention and Treatment from June 2016 to December 2017, 93 males (87.7%) and 13 females (12.3%). According to the ZSDS scores, 106 occupational NIHL patients were divided into two groups: 57 in ONHLPD and 49 in non-ONHLPD. Therefore, in this study, the prevalence of depressive symptoms was 53.8% (57/106) in patients with occupational NIHL. Among 57 occupational NIHL patients with depressive symptoms, 29 occupational NIHL patients (27.4 %) suffered from mild depression, 21 patients (19.8 %) suffered from moderate depression, while 7 patients (6.6 %) had severe depression [Figure 1].

**Analysis of general data between two groups**

General characteristics can be shown in Table 1. The ages of these patients ranged from 25 to 60 with a mean age of 42.88 ± 7.35 years old in ONHLPD and 41.5±7.32 in non-ONHLPD. In ONHLPD, 14% of them were primary school education, and 49.1% were middle school education and 36.8% were college education or higher. In non-ONHLPD,
14.3% were primary school education, and 51% were middle school education and 34.7% were college education or higher. The t-test and chi-square tests showed that there were no significant differences between the two groups in terms of age, gender and educational level ($P > 0.05$).

Analysis of characteristics of noise-induced hearing loss between two groups

Table 2 shows the results of the comparison of THI scores, PSQI scores, cortisol level and duration of ONIHL, auditory thresholds, noise level and years of working between two groups. Occupational NIHL patients in ONHLPD recorded a longer duration of occupational NIHL ($Z = -3.419, P < 0.01$) and higher serum cortisol level than those in non-ONHLPD ($t = 2.996, P < 0.01$). Patients with depression also had a higher PQSI score ($x^2 = 50.941, P < 0.01$) and higher THI score ($x^2 = 43.289, P < 0.01$). There were no significant differences between the auditory thresholds, noise level and years of working in two groups ($P > 0.05$).

Correlation analysis between characteristics of noise-induced hearing loss in two groups

In ONHLPD, cortisol level was positively correlated with the duration of occupational NIHL ($r = 0.297, P > 0.01$), and THI scores were positively correlated with auditory threshold ($r = 0.362, P < 0.01$). However, in non-ONHLPD, only auditory threshold was positively correlated with the noise level ($r = 0.436, P < 0.01$). Furthermore, THI scores were significantly positively correlated with PSQI scores in both two groups ($r = 0.327, P = 0.013; r = 0.476, P < 0.01$) [Table 3].

Correlation analysis between depression and other relevant factors of Occupational NIHL

To identify the relevant factors of occupational NIHL to depressive status, Pearson correlation analysis was first applied to study the relationship between depressive status and various factors. The results indicated that higher depressive status was positively correlated with...
The THI score, PSQI score and duration of occupational NIHL in total patients of occupational NIHL ($r = 0.77$, $P < 0.001$; $r = 0.71$, $P < 0.001$; $r = 0.21$, $P = 0.031$) (Table 4). For Pearson correlation analysis can only check depressive status with other variables, to integrate multiple independent variables into depression status analyses, multiple linear regression models with enter analysis were carried out. ZSDS scores, THI scores, PSQI scores, cortisol level, duration of hearing loss, threshold of hearing, noise intensity, working age of the patient, sex and education were all regarded as independent variables [Table 5]. The results of multiple linear regression models in all the patients also supported that PSQI scores, THI scores and duration of occupational NIHL had positive associations with ZSDS scores ($\beta = 0.55$, $P < 0.001$; $\beta = 0.33$, $P < 0.001$; $\beta = 0.11$, $P < 0.05$).

### DISCUSSION

Empirical data about the incidence of depression in hearing loss patients with occupational NIHL are still lacking. In this study, it was found that 53.8% of patients with occupational NIHL reported depressive symptoms. Similar to our result, previous evidence suggested that hearing loss adults have a higher prevalence of depressive symptoms than those without hearing loss.[26-28] For example, one study was conducted to examine the relationship between depression and self-reported hearing loss for US adults aged 18 years or older, which showed that prevalence of moderate to severe depression was 11.4% for adults with any self-reported hearing loss and 5.9% for those whom had normal hearing.[29] Combine with previous studies, more than half incidence rate of depression in our patients with occupational NIHL suggested that health care professionals among patients...
with occupational hearing loss should be aware of an increased risk for depression.

Previous studies have not identified the relationship between the severity of depression and the level of occupational noise exposed. In this study, no significant differences were discovered in the level of occupational noise exposed between two groups. A study from Japan about the aircraft noise identified that depression was significantly influenced by the intense of noise exposure, and the rates of mental illness increasing according to noise level. This finding was different from the result from our study. Besides the differences in level and source, subjects of this research all have left their working place for months or years after hearing loss, so the occupational noise exposure had weaker influence on them, and this was considered as one of the causes of the differences.

In addition, data of this study also showed that auditory thresholds were not correlated with the severity of depression. This finding keeps pace with one previous investigation that hearing loss did not appear increased risk of major depressive disorder in Hispanics. In contrast, Li et al. reported that there was a significant association between depression and a threshold-based measure of moderate hearing loss in US adults. These apparently inconsistent results may be related to the differences of age, ethnically distinct populations or methods applied to access the hearing loss.

The present study showed that duration of occupational NIHL was strongly related to the depressive symptoms and indicated that it was a major risk factor for depressive symptoms. Disease duration is a variable strongly related to depression in some special diseases, such as obesity, Parkinson’s disease and post stroke. In general, those studies found that the longer the duration of the disease, the higher the incidence rate of depression. Additionally, previous studies showed that the level of depression did not correlate with severity of tinnitus but duration of it. Thereby, these findings suggest that longer duration may contribute to the higher depression score.

This study found that there were sleep disorders in 84.2% of patients with occupational NIHL in ONHLPD, but only 20.4% in non-ONHLPD. These findings consistent with a previous study reported that insomnia might occur in 60%–80% of depression patients. In this study, both Pearson correlation analysis and multiple linear regression analysis suggested that sleep quality was significantly associated with depressive score; good sleep quality was conducive to reduce the level of depression. It is consistent with the previous studies on depression patients. Finding of this study suggested that sleep quality was considered as a risk factor for depression, disordered sleep was considered as an important comorbid condition in patients with depression, for some researchers suggested that the relationship between insomnia and depressive disorders was reciprocal. Previous clinical interviews suggested that a large variable prevalence rate of depressive disorders in tinnitus patients was from 14% to 80%. In this study, strong correlations between tinnitus scores (THI) and ZSDS was found. Similar to this study, a lot of previous clinical studies have demonstrated a clear and linear relationship between tinnitus and depression. Although multiple linear regression analysis suggested that tinnitus could be a riskier factor for depressive symptoms, the interpretation still needed to be treated with caution, for severe tinnitus may cause depression; alternatively, the presence of depression may reduce an individual’s tolerance of tinnitus, leading to exaggeration of the symptoms to tinnitus. Furthermore, Deniz and his colleagues showed both depression and tinnitus had a similar molecular mechanism of serotonin disorder. Thereby, a cause-and-effect relationship between tinnitus and depression can be set up, tinnitus can cause or be caused by depression, but it is difficult to know what came first. In the mean time, a significant relationship between tinnitus and sleep quality both in ONHLPD and non-ONHLPD was observed, the poorer sleep quality, the severer annoyance and intensity of tinnitus. Similarly, previous studies showed that the prevalence of sleep disorders in tinnitus sufferers varied from 25% to 77%, and insomnia was one of the most common problems reported by patients with tinnitus. However, it still remains unclear whether sleep disorder is a consequence or a comorbid condition of tinnitus sufferers. Thus further studies are needed to examine whether tinnitus leads to sleep disorder or vice versa.

Cortisol is the principal hormonal product of human hypothalamic–pituitary–adrenal (HPA) axis, a close-looped endocrine system, which has been suggested as a stress marker and a useful tool to measure noise-related stress. Recently, some researchers begin to determine the HPA axis that contributes to the onset and occurrence of depression. Although this study found that mean value
of cortisol was higher in ONHLPD [Table 2], both the Pearson correlation analysis and multiple linear regression models showed that cortisol level was not a risk factor for occupational NIHL patients’ depressive symptoms [Tables 4 and 5]. In addition, patients in ONHLPD had longer course of occupational NIHL [Table 2] and cortisol was positively relevant to duration of occupational NIHL in ONHLPD [Table 3]. Thus, it could be suspected that the elevated cortisol level could be the result of longer course of occupational NIHL, but not depressive symptoms.

Some limitations in this study should be acknowledged. First, relatively small samples may not be entirely adequate to avoid systematic bias effects and inflated effect size estimates. Second, selection bias could exist since the subjects in this study were conveniently chosen from the specialized occupational-disease-prevention hospital set up by the provincial government of Guangdong province. Thus, caution should be exercised when extrapolating this study results to nationwide or a broader area. Third, the direction of causality between depression states and related factors cannot be determined because of the cross-sectional design. Thus larger and more diverse population-based samples studies need to be done in future.

In conclusion, the major findings of this study are as follows: (1) results showed that a high prevalence (53.8%) of depressive symptoms in patients with occupational NIHL, the effects of hearing loss by occupational noise on psychiatric disorders especially depressive symptoms should not be ignored. (2) There is a correlation between duration of hearing loss and depression, however, the level of occupational noise exposure and auditory thresholds do not correlate with the severity of depression. (3) Although mean value of cortisol was higher in ONHLPD, cortisol level was not a risk factor for occupational NIHL patients’ depressive symptoms. (4) There are correlations among scores of sleep, tinnitus and depression. The relationships between them may be reciprocal. All these findings should be taken into consideration in the treatment of patients who suffer from occupational NIHL.

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Conflicts of interest

There are no conflicts of interest.

References

1. Hong O, Kerr MJ, Poling GL, Dhar S. Understanding and preventing noise-induced hearing loss. Dis Mon 2013;59:110-8.
2. Nelson DJ, Nelson RY, Concha-Barrientos M, Fingerhut M. The global burden of occupational noise-induced hearing loss. Am J Ind Med 2005;48:446-8.
3. National Institute for Occupational Safety and Health (NIOSH) noise and hearing loss prevention. 2013. Available at: http://www.cdc.gov/niosh/topics/noise/
4. National Health and Family Planning Commission of the People’s Republic of China. 2013. Available at: http://www.nhfpc.gov.cn/jkj/s58999/201406/ed8ed220d0b784
5. Rabat A. Extra-auditory effects of noise in laboratory animals: the relationship between noise and sleep. J Am Assoc Lab Anim Sci 2007;46:35-41.
6. Basner M, Babisch W, Davis A. Auditory and non-auditory effects of noise on health. Lancet 2014;383:1325-32.
7. Berghard B. LTSD. Guidelines for Community Noise. World Health Organization 1999-2017-2019.
8. Ferrari AJ, Charlson FJ, Norman RE. The epidemiological modelling of major depressive disorder: Application for the Global Burden of Disease Study 2010. PLOS one 2013;8:e69637.
9. Ferrari AJ CFNR. The epidemiological modelling of major depressive disorder: Application for the Global Burden of Disease Study 2010. PLOS one 2013;9:63-9.
10. Tambs K. Moderate effects of hearing loss on mental health and subjective well-being: Results from the Nord-Trondelag Hearing Loss Study. Psychosom Med 2004;66:776-82.
11. Tarnopolsky A, Watkins G, Hand DJ. Aircraft noise and mental health: I. Prevalence of individual symptoms. Psychol Med 1980;10:683-98.
12. Hiramatsu K, Yamamoto T, Taia K, Ito A, Nakasone T. A survey on health effects due to aircraft noise on residents living around kadena air base in the rukyus. J Sound Vib 1997;205:451-60.
13. Yoon JH, Won Ju, Lee W, Jung PK, Roh J. Occupational noise annoyance linked to depressive symptoms and suicidal ideation: A result from nationwide survey of Korea. PLOS One 2014;9:e105321.
14. Kryter KD. Aircraft noise and social factors in psychiatric hospital admission rates: A re-examination of some data. Psychol Med 1990;20:395-411.
15. Stansfeld S, Gallacher J, Babisch W, Shipley M. Road traffic noise and psychiatric disorder: Prospective findings from the Caerphilly Study. BMJ 1996;313:266-7.
16. Ministry of Health of the People’s Republic of China. GBZ 49—2014 Diagnosis of occupational noise-induced deafness. 2014.
17. Zung WW. A self-rating depression scale. Arch Gen Psychiatry 1965;12:63-70.
18. Lee HC, Chiu HF, Wing YK, Leung CM, Kwok PK, Chung DW. The Zung Self-rating Depression Scale: Screening for depression among the Hong Kong Chinese elderly. J Geriatr Psychiatry Neurol 1994;7:216-20.
19. Wang XQ, Lambert CE, Lambert VA. Anxiety, depression and coping strategies in post-hysterectomy Chinese women prior to discharge. Int Nurs Rev 2007;54:271-9.
20. Yang XJ, Jiang HM, Hou XH, Song J. Anxiety and depression in patients with gastroesophageal reflux disease and their effect on quality of life. World J Gastroenterol 2015;21:4302-9.
21. SHI Qiu-lan BXWJ. Translation and application of tinnitus handicap inventory in Chinese vers ion. Acta Universitatis Medicinalis Nanjing (Natural Science) 2007:476-9.
22. McCombe A, Baguley D, Coles R, McKenzie L, McKinney C, Windle-Taylor P. Guidelines for the grading of tinnitus severity: the results of a working group commissioned by the British Association of Otolaryngologists, Head and Neck Surgeons. Clin Otolaryngol Allied Sci 2001;26:388-93.
23. Tsai PS, Wang SY, Wang MY, et al. Psychometric evaluation of the Chinese version of the Pittsburgh Sleep Quality Index (CPSQI) in primary insomnia and control subjects. Qual Life Res 2005;14:1943-52.
24. Buyse DJ, Reynolds CR, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
25. World Health Organization Prevention of Blindness and Deafness (PBD) Program. Prevention of Deafness and Hearing Impaired Grades of Hearing Impairment.

26. Bernabei V, Morini V, Moretti F. Vision and hearing impairments are associated with depressive – anxiety syndrome in Italian elderly. Aging Ment Health 2011;15:467-74.

27. Zazove P, Meador HE, Aikens JE, Nease DE, Gorenflo DW. Assessment of depressive symptoms in deaf persons. J Am Board Fam Med 2006;19:141-7.

28. Boorsma M, Joling K, Dussel M. The incidence of depression and its risk factors in Dutch nursing homes and residential care homes. Am J Geriatr Psychiatry 2012;20:932-42.

29. Li CM, Zhang X, Hoffman HJ, Themann CL, Wilson MR. Hearing impairment associated with depression in US adults. National Health and Nutrition Examination Survey 2005-2010. JAMA Otolaryngol Head Neck Surg 2014;140:293-302.

30. Lee DJ, Gomez-Marín O. Major depressive disorder, depressive symptoms, and bilateral hearing loss in hispanic adults. J Affect Disord 1997;44:189-95.

31. Opel N, Redlich R, Grotegerd D. Obesity and major depression: Body-mass index (BMI) is associated with a severe course of disease and specific neurostructural alterations. Psychoneuroendocrino 2015;51:219-26.

32. Dissanyake NN, O’Sullivan JD, Silburn PA, Mellick GD. Assessment methods and factors associated with depression in Parkinson’s disease. J Neurol Sci 2011;310:208-10.

33. Sun N, Li Q, Lv D, Man J, Liu X, Sun M. A Survey on 465 Patients With Post-Stroke Depression in China. Arch Psychiat Nurs 2014;28:368-71.

34. Malakouti S, Mahmoudian M, Alifattahi N, Salehi M. Comorbidity of chronic tinnitus and mental disorders. Int Tinnitus J 2011;16:118-22.

35. Gomaa MA, Elmagd MH, Elbadry MM, Kader RM. Depression, anxiety and stress scale in patients with tinnitus and hearing loss. Eur Arch Otorhinolaryngol 2014;271:2177-84.

36. Winokur A, Gary KA, Rodner S, Rae-Red C, Fernando AT, Szuba MP. Depression, sleep physiology, and antidepressant drugs. Depress Anxiety 2001;14:19-28.

37. Breslau N, Roth T, Rosenthal L, Andreski P. Sleep disturbance and psychiatric disorders: A longitudinal epidemiological study of young adults. Biol Psychiatry 1996;39:411-8.

38. Rusch HL, Guardado P, Baxter T, Mysliwiec V, Gill JM. Improved sleep quality is associated with reductions in depression and PTSD arousal symptoms and increases in IGF-1 concentrations. J Clin Sleep Med 2015;11:615-23.

39. Lustberg L, Reynolds CF. Depression and insomnia: Questions of cause and effect. Sleep Med Rev 2000;4:253-62.

40. Langguth B, Landgrebe M, Kleinjung T, Sand GP, Hajak G. Tinnitus and depression. World J Biol Psychiatry 2011;12:489-500.

41. Weber JH, Jagsch R, Hallas B. The relationship between tinnitus, personality, and depression. Z Psychosom Med Psychother 2008;54:227-40.

42. Shargorodsky J, Curhan GC, Farwell WR. Prevalence and characteristics of tinnitus among US adults. Am J Med 2010;123:711-8.

43. Deniz M, Bayazit YA, Celenk F. Significance of serotonin transporter gene polymorphism in tinnitus. Otol Neurotol 2010;31:19-24.

44. Cronlein T, Langguth B, Geisler P, Hajak G. Tinnitus and insomnia. Prog Brain Res 2007;166:227-33.

45. McKenna L. Tinnitus and insomnia. In: Tyler RSE. Tinnitus Handbook. 2000. San Diego: Singular.

46. Alessandra B, Fioretti MFAE. Association between sleep disorders, hyperacusis and tinnitus: Evaluation with tinnitus questionnaires. Noise Health 2013;63:75-83.

47. Bigtirt C, Bluhm G, Theorell T. Saliva cortisol – A new approach in noise research to study stress effects. Int J Hyg Environ Health 2005;208:227-30.

48. Georgia E, Hodes VKCM. Neuroimmune mechanisms of depression. Nat Neurosci 2015;10:1386-93.