

RESEARCH ARTICLE

The relation among tinnitus distress, psychoacoustic parameters and anxiety state in hearing-impaired patients with chronic tinnitus: a pilot study

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Abstract

Background and Aim: Anxiety and depression are prevalent psychological disorders accompany tinnitus that have adverse effects on quality of life of these patients and on the outcomes of rehabilitation programs. The goal of this study was determining and quantifying the relation among perceived tinnitus severity, its psychoacoustic parameters and anxiety symptoms in hearing-impaired individuals with subjective chronic tinnitus and residual inhibition (RI) by using Persian version of Spielberger's State-Trait Anxiety Inventory (STAI), tinnitus handicap inventory-Persian version (THI-P) and visual analogue scale (VAS) besides psychometric evaluations.

Methods: Fourteen patients with chronic tinnitus were enrolled in this cross-sectional study. Conventional psychoacoustic tinnitus evaluations (i.e. determining quality of tinnitus, pitch matching, loudness matching, minimum masking level and RI) were conducted for all subjects, and they also completed the Persian version of STAI and THI-P. For screening of tinnitus perceived loudness and distress, VAS was used.

Results: There was no correlation among THI-P, VAS scores and psychoacoustic parameters. There was a positive significant correlation between THI-P and Persian STAI scores ($r = 0.63$; $p = 0.01$). There was not any significant correlation between tinnitus duration and VAS, STAI or THI-P. There also had no significant correlation between VAS and THI-P ($r = 0.56$; $p = 0.2$).

Conclusion: The present pilot study showed that Persian version of THI and STAI are correlated questionnaires. Therefore, Persian version of these questionnaires are valuable tools for evaluation of patients with chronic tinnitus.

Keywords: Anxiety; tinnitus; tinnitus handicap inventory; state-trait anxiety inventory; visual analog scale; psychoacoustics

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Introduction

Tinnitus is one of the consequences of damage to the auditory system from cochlea to higher

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central auditory stages which can occur following or independent of hearing loss [1,2]. Different reasons have been proposed for incidence of tinnitus, including exposure to loud noises, use of ototoxic drugs, presbycusis, and psychological stresses [3,4]. Tinnitus can be subjective or objective. Subjective tinnitus is perception of sound in the absence of an external acoustic stimulus and is heard only by the patient [3]. The increase in prevalence of chronic tinnitus and the high prevalence of disorders such as insomnia, anxiety, depression, or even suicide in patients with debilitating tinnitus [5-7] highlight the necessity of timely rehabilitation interventions in these patients.

The prerequisite to proper selection and timely practice of rehabilitation methods is conducting comprehensive and interdisciplinary assessments. Because of the subjective nature of tinnitus as well as the limited sensitivity of tinnitus assessments in predicting the impact of this phenomenon on patients' lifestyle, usage of self-report questionnaires has found interest [8]. Various questionnaires have been presented to investigate different aspects of tinnitus and its impact on the patient's life. One of the popular tinnitus questionnaires is tinnitus handicap inventory (THI) which is mostly used and valid tool for evaluation of the tinnitus effects on different aspects of affected subjects [9]. THI was introduced and revised by Newman et al. (1996) [10] and was translated to Persian by Mahmoudian et al. (THI-P) [11]. It includes 25 items in three separate subscales: functional (relating to role limitations in the areas of mental functioning, social/occupational functioning, physical functioning); emotional (relating to affective responses to tinnitus); and catastrophic (relating to patients' desperation, inability to escape from tinnitus, perception of having a terrible disease, lack of control, and inability to cope) [10,11]. This questionnaire has been studied vastly and has proven to be efficient, valid and reliable tool for revealing detailed information about tinnitus adverse effects quantitatively [11-14]. On the other hand, visual analogue scale (VAS) is another self-assessment tool which allows the clinician to quickly obtain useful information about

the loudness of tinnitus, its annoyance, and the related distress. In this scale, individual should assign a number between 0 and 10 to the questioned item. In many clinical settings, VAS is most preferred and practical tool for quick evaluation of its self-perceived effects [15,16]. In general, it cannot provide a detailed quantitative assessment of tinnitus [16] but if it can show good correlation with other valid and quantitative tools such as THI, it can be used more confidently in clinic settings.

Because of the potential effects of tinnitus on patients' psychological factors, different studies have been conducted on the relationship between scores of tinnitus self-assessment questionnaires and the results obtained from psychological evaluation. One of the psychological questionnaires is the Spielberger State-Trait Anxiety Inventory (STAI) which was developed by Spielberger et al. [17]. The Persian version of STAI was developed by Mahram [18], has been a commonly-used measure of state and trait anxiety in research and clinical practice. This scale is suggested by psychologists for evaluation of anxiety and can use for treatment outcome monitoring [19,20]. STAI questionnaire consists of two version: y1 or state version (STAI-S) deals with investigating the anxiety of the person at the time of responding to the relevant form, while y2 or trait version (STAI-T) evaluates the general emotions of the person. The participants should respond to the items through four options: very low, low, high, and very high [17].

There are studies on the relation between THI and STAI in other languages but to the best of our knowledge there is no study conducted in Iran. The results of all previous studies suggest a direct relationship between the extents of distress caused by tinnitus and increased prevalence of psychological disorders [5,21,22]. The strength of obtained correlation, the target psychological characteristics that have been studied and the used tool for evaluation were different among studies. In addition, studies have shown that the prevalence of anxiety and stress is higher in Iranian population than the average of the world population [23]. Tinnitus has the potential to affect the stress and anxiety level in individuals.

Nascimento et al. stated that currently, the most used tools for evaluation of patients with tinnitus are THI, VAS, and pitch and loudness matching. So standardization of these methods and the identification of the relationship among them is extremely important [24]. In this study, we investigated the anxiety level of Iranian patients who suffered from hearing loss and chronic tinnitus by using THI-P and the Persian version of STAI. In addition, the relationship between the THI-P and the VAS scores (loudness and distress) was investigated to examine the potential accuracy of simply using VAS score for screening patients who need more comprehensive psychological consultation and intervention. To the best of our knowledge it is the first study conducted using Persian version of THI and STAI on hearing-impaired patients with chronic tinnitus and residual inhibition, and the results of this pilot study can shed light on the handicap and anxiety related to chronic tinnitus in Iranian population.

Methods

Fourteen patients with sensory-neural hearing loss (SNHL) and chronic tinnitus have participated in this pilot study. Participants were all males, with the age range of 40 to 65 years (mean = 54.57 SD = 6.22 yrs.). They were chosen by simple sampling method among the clients of Audiology clinic of Tehran University of Medical Sciences.

Otoscopy, Tympanometry and pure tone audiometry in conventional frequencies was conducted and patients without middle ear pathologies and mild to moderate sensory-neural hearing loss (SNHL) were selected. Other inclusion criteria were as follow: at least high school education, having tinnitus at least for one year and no history of antidepressant or any neurologic medications and alcohol use in the three months leading up to the study. Patients could have monaural or binaural tinnitus. In patients with binaural tinnitus, the ear with louder perceived tinnitus was selected for psychometric evaluations. In patients with symmetric tinnitus perception, right ear was selected for psychometric evaluations. Subjects were asked to complete THI-P [11] and Persian version of STAI [18] questionnaires and

scored distress and loudness of their tinnitus via VAS from 0 to 10. Then psychoacoustic evaluations of tinnitus were employed. Pitch matching was done via two-alternative forced choice (TAFC) method. In this test, patients must choose the most similar presented stimulus to their tinnitus pitch. After that, in order to minimize the patient's error, octave confusion test were done. Loudness matching was evaluated by ascending method and then minimum masking level (MML) was assessed. So a narrowband noise (NBN) in the frequency of the tinnitus pitch (based on the pitch matching results) were presented ipsilaterally below the hearing threshold level of that given frequency and then the presentation level was increased in 2 dB-step until reaching the patient's threshold. After that noise intensity level was increased till the patient could not hear his tinnitus. This level was determined as MML (in dB SL). At the end, this noise was presented in 10 dB SL re: MML for one minute to evaluate RI. Then, the patients were asked to score distress and loudness of their tinnitus via VAS one more time. If the scores change was three points or more, the RI test was positive, otherwise if the score change was less than three, the RI test was negative and patients were excluded from the study.

Spearman correlation test was used to assess the correlation among the data obtained from the THI-P, STAI, VAS questionnaires and the results of psychoacoustic evaluations. The power and acceptable error of this pilot study were 80% and 0.05, respectively. All statistical analyzes were performed using SPSS 17.

Results

The summary of demographic data and the results of psychometric and self-report evaluations are given in Table 1 and 2. Eleven patients had bilateral and three patients had unilateral SNHL. Their average hearing thresholds of mid frequencies were 42.70 dB (SD = 13.00) and 69.16 dB (SD = 15.76) for high frequencies (4000 and 8000 Hz).

Mean of tinnitus pitch, loudness, MML, scores of distress and loudness based on VAS, THI-P and STAI scores are presented in Table 2. THI-P

Table 1. Demographic data of patients

Case	Age (year)	PTA (dB HL)	LDL (dB HL)	Tinnitus side	Tinnitus duration (year)	Tinnitus quality
C1	60	43.33	87	L	35	NBN
C2	54	48.33	92	L	23	Tonal
C3	41	15.00	100	L	14	NBN
C4	56	50.00	110	L	6	Tonal
C5	58	60.00	100	R	12	Tonal
C6	53	41.25	70	R	29	NBN
C7	53	60.00	65	L	21	NBN
C8	52	53.33	81	L	31	Tonal
C9	60	41.66	100	L	23	Tonal
C10	52	45.00	80	R	33	NBN
C11	50	46.66	77	L	12	NBN
C12	57	33.33	87	L	27	Tonal
C13	65	20.00	83	R	4	NBN
C14	51	40.00	90	L	30	NBN

PTA; pure tone average, LDL; loudness discomfort level, NBN; narrow band noise, L; left, R; right

scores showed 57.1% of patients had severe and catastrophic tinnitus, 28.6% and 14.3% had mild and slight tinnitus. Based on STAI scores, half of patients (50%) had severe and the others had slight to moderate state anxiety. In addition, 85.7% had slight to moderate and 14.3% had severe trait anxiety. There was not any significant correlation between tinnitus duration and VAS ($r = 0.01$), STAI ($r = 0.10$) or THI-P ($r = 0.08$) ($p > 0.05$).

While Spearman test demonstrated no significant correlation between THI and VAS scores and psychoacoustic parameters of tinnitus ($p > 0.05$), there was a positive significant correlation between THI-P and STAI scores ($r = 0.63$ and $p < 0.05$). There also showed no significant correlation between VAS and THI-P ($r = 0.56$; $p = 0.2$) Table 3.

Fig. 1 shows that scatterplot of the relation between Persian version of STAI and THI-P score.

Discussion

In the present pilot study, the STAI score of hearing-impaired individuals with chronic tinnitus was significantly higher than the mean level of anxiety of normal individuals. It seems that the extent of negative attitudes of individuals with tinnitus to its cause and consequences is the main determinant of the extent of disturbance induced by tinnitus. This causes exacerbated anxiety of patients about tinnitus. STAI can evaluate both state and trait anxious behaviors [17]. Cho et al. evaluated the relationship between tinnitus and the level of anxiety and depression experienced in patients with subjective tinnitus. They used THI, Beck depression index (BDI), and STAI and found significant correlation among THI scores BDI and STAI scores for patients with moderate and severe tinnitus [25]. In the present study, the correlation was seen between THI-P and STAI for all degrees of anxiety and handicap levels (from slight to severe). This is in

Table 2. Mean and standard deviation of psychometric and self-report evaluations

Case	Pitch (kHz)	Loudness (dB SL)	MML (dB SL)	VAS loudness	VAS distress	THI-P	STAI-S	STAI-T
C1	3	5	6	4	3	8	21	21
C2	2	10	35	7	5	26	34	32
C3	4	9	12	7	8	44	45	42
C4	6	10	6	8	5	20	34	42
C5	6	9	12	9	10	80	61	47
C6	2	3	2	6	5	74	56	52
C7	8	2	2	7	6	74	56	52
C8	4	2	6	4	7	36	58	51
C9	8	4	15	7	7	76	61	76
C10	3	2	3	8	6	88	47	31
C11	8	11	3	10	8	82	38	34
C12	6	8	14	5	5	80	63	63
C13	4	5	2	10	10	16	29	31
C14	6	5	10	8	8	82	60	50
Mean	5.00	6.07	9.14	7.14	6.24	56.14	47.36	44.57
SD	2.14	3.31	8.77	1.91	2.02	14.46	13.92	14.46

MML; minimum masking level, VAS; visual analogue scale, THI-P; tinnitus handicap inventory-Persian, STAI-S; state-trait anxiety inventory-state anxiety, STAI-T; state-trait anxiety inventory-trait anxiety, SD; standard deviation

agreement with Gomaa et al. who showed that severity of tinnitus did not affect severity of anxiety and depression [21]. Ooms et al. studied cognitive and somatic anxiety symptoms via Dutch version of STAI on 71 patients with tinnitus. They studied psychometric characteristics of tinnitus by pitch and loudness matching and also evaluated tinnitus effects on daily activities through Dutch THI. They showed that almost 60% of the sample reported more than average state and trait anxiety [26]. In the present study, half of patients had severe state anxiety and only 14.3% had severe trait anxiety, so in general most of the hearing-impaired patients with chronic tinnitus suffered from severe state anxiety. Anxiety has two components: state and trait. State anxiety is a personality characteristic which develops based on the extent of exposure to

threatening and dangerous situations. This component indicates the extent to which one is likely to experience anxiety in exposure to immediate stressful situations. Trait anxiety refers to the stable tendency to attend to, experience, and report negative emotions such as fears, worries, and anxiety across many situations [17-19]. It seems that in Iranian population state anxiety related to tinnitus is high and can indicate that subjects with chronic tinnitus consider their tinnitus as a threatening and dangerous situation. This might be an inherent personality issue in our society or secondary to lack of providing enough psychologically-approved consultation to the affected patients. In other words, it shows that patients even after months, and in spite of thorough clinical evaluations, still are not sure about safe nature of their tinnitus and could not compensate it. This is

Table 3. The correlation between psychoacoustic parameters of tinnitus, visual analogue scale scores, state trait anxiety inventory and tinnitus handicap inventory questionnaire

		Psychoacoustical parameters			VAS		STAI	
		Pitch	Loudness	MML	Loudness	Distress	STAI-S	STAI-T
THI-P	r	0.37	-0.09	0.06	0.32	0.31	0.63	0.31
	p	0.18	0.75	0.83	0.26	0.27	0.01	0.26

VAS; visual analogue scale, STAI; state-trait anxiety inventory, MML; minimum masking level, STAI-S; state anxiety, STAI-T; trait anxiety, THI-P; tinnitus handicap inventory-Persian

the pilot study and more study with larger sample size is needed for generalization. However, in this first pilot study, a significant finding has been shown and the reason behind it needs more studies. Udupi et al. in a study in India showed that THI scores also had significant positive correlation with both state ($r = 0.602$) and trait ($r = 0.426$) anxiety levels ($p < 0.01$) but correlation with state anxiety was higher than trait anxiety [27]. The result of the present study is in agreement with Udupi et al. It seems that the type of anxiety-induced by tinnitus might be different than normal people.

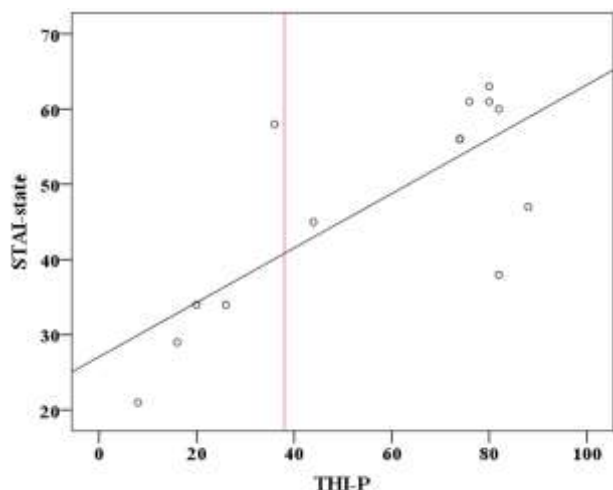


Fig. 1. Scatterplot of the correlation between state version of the state trait anxiety inventory and tinnitus handicap inventory-Persian score. STAI; state-trait anxiety inventory, THI-P; tinnitus handicap inventory-Persian score.

In addition, in the present pilot study, there was not any significant correlation between tinnitus duration and STAI or THI-P, which again it is indicative of existence of anxiety and handicap regardless of time after tinnitus occurrence. It seems again patients still have not accepted the safe nature of their tinnitus despite them suffering from tinnitus for a relatively long period of time. Gomaa et al. found that the duration of tinnitus had positive correlation on both severities of depression and severity of anxiety [21]. Zachariae et al. found no significant correlations between the THI and the duration of tinnitus. They suggest that while chronic tinnitus sufferers may be unable to adapt to their symptoms, longer duration, on the other hand, may not be associated with an increase in the adverse effects on daily living [28].

The pathophysiologic link between tinnitus and psychologic manifestations has been studied for many years. A group of researchers believe that tinnitus results in anxiety, while others argue that tinnitus follows these disorders [29-31]. Jastreboff and Jastreboff, in their neurophysiological theory, combined these different perspectives. Based on this theory, if the first experience of tinnitus is associated with high degrees of anxiety and depression, tinnitus becomes the main problem for the person. In these conditions, anxiety further aggravates tinnitus and its disturbance and a vicious cycle forms [32]. Limbic system especially amygdala of course plays an important part in the relation between tinnitus and anxiety. Imaging studies (including fMRI and PET scan) in patients with chronic tinnitus show that limbic

system is hyperactive [33,34]. Ziai et al. propounded another hypothesis known as cortisol mediator to justify the relationship between tinnitus and psychological disorders. Based on this hypothesis, large amounts of cortisol were produced in the body of individuals with tinnitus. High concentration of cortisol is directly associated with incidence of disorders such as anxiety and depression. On the other hand, incidence of psychological disorders causes exacerbation on of the disturbance caused by tinnitus, and hence a vicious cycle develops in these patients. According to this cycle, development of psychological disorders aggravates tinnitus disturbance, while this increased disturbance further deteriorates the level of anxiety and stress in these individuals [35].

In the present study, no significant relationship was observed between the score obtained from THI-P and VAS and also psychoacoustic assessments of tinnitus. This finding was in agreement with Meikle et al. and Ooms et al. showed that there was not any significant relation between psychometric tinnitus characteristics and anxiety level or handicap experienced (via THI) in patients with tinnitus [26,36]. This finding supports that the audiological evaluations of tinnitus do not determine the subjects' handicap and anxiety and cannot be used as a predictive factor. In fact although psychometric evaluations of tinnitus despite are bias-free and informative, they cannot be an alternative for subjective self-report evaluations in these subjects.

Nascimento et al. stated that although VAS is widely used clinically, it has not yet been systematically validated for the evaluation of different aspects of tinnitus [24]. They showed that a strong positive correlation was observed between THI and VAS and suggested that even though THI is a more comprehensive evaluation, the use of VAS is simpler and easier for patients to assimilate and it is equally reliable. Crocetti et al. and Udipi et al. also showed significant correlation between VAS and THI [27,37]. But the present study is not in agreement with these studies. It seems that VAS as a quick and simple screening tool for evaluation of loudness, awareness and distress in patients with tinnitus might be a valid

tool and can be used in practice, although it is not as accurate as comprehensive questionnaires like THI. More research is needed for generalization of the results.

Conclusion

The present pilot study showed that Persian version of THI and STAI are correlated questionnaires Therefore Persian version of these questionnaires are valuable tools for evaluation of patients with chronic tinnitus.

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Conflict of interest

No potential conflict of interest relevant to this article was reported.

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