

## ORIGINAL RESEARCH

# Clinical characteristics and psychoacoustic analysis of acute and chronic subjective tinnitus

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## Abstract

**Objective:** This study aimed to understand the demographics, clinical characteristics, and psychoacoustic status of subjective tinnitus patients to explore the factors associated with acute and chronic tinnitus in the general hospitals of Shanghai.

**Methods:** A cross-sectional study was conducted to investigate the clinical characteristics and psychoacoustic status of subjective tinnitus patients with history greater than 1 month. Data were collected during January 2021 and January 2022 from eight general hospitals in five districts of Shanghai, China. All patients accepted questionnaires and acoustic examination, then SPSS 22.0 and GraphPad Prism 8.0.2 were applied for data analysis.

**Results:** Among the 359 tinnitus patients, 126 cases were diagnosed with acute tinnitus, 58 cases were subacute tinnitus, and 175 cases were chronic tinnitus. Patients with acute and chronic tinnitus differed in terms of side of tinnitus, hearing loss, frequency of tinnitus, severity of tinnitus, anxiety, depression, and sleep status. Different characteristics were included in the multivariate ordinal logistic regression analysis. Persistent tinnitus (OR = 2.00,  $p = .008$ ), high frequency hearing loss (OR = 4.77,  $p < .001$ ), depression (OR = 1.23,  $p < .001$ ) were found to be positively associated with the course of tinnitus. Unilateral tinnitus (OR = 0.48,  $p = .003$ ), mild (OR = 0.29,  $p = .001$ ) and moderate (OR = 0.46,  $p = .038$ ) hearing loss, VAS scores (OR = 0.82,  $p = .032$ ), anxiety (OR = 0.81,  $p < .001$ ), THI scores (OR = 0.98,  $p = .002$ ), and sleep disorders (OR = 0.94,  $p = .025$ ) were found to be negatively associated with the course of tinnitus.

**Conclusion:** Patients with acute tinnitus were at greater risk for anxiety, sleep disturbances, and exacerbation of tinnitus perception, and those with chronic tinnitus were at greater risk for depression.

**Lay Summary:** Our study demonstrated that patients with acute tinnitus were at greater risk for anxiety, sleep disturbances, and exacerbation of tinnitus perception, and those with chronic tinnitus were at greater risk for depression.

Haopeng Zhang and Lin Ji contributed equally to this study.

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## KEYWORDS

anxiety, cross-sectional study, depression, sleep disorders, tinnitus

## 1 | INTRODUCTION

Tinnitus refers to the sensation of one or more sounds produced without an external sound source. In epidemiological studies worldwide, approximately 10%–15% of adults will suffer from tinnitus, of which approximately 20% require clinical intervention.<sup>1</sup> In China, due to the lack of large-scale epidemiological surveys, tinnitus prevalence is estimated to range from 7.8% to 30.4%, varied with age, gender, hearing loss, noise exposure, and poor sleep, and shows a gradually increasing trend.<sup>2</sup> Severe tinnitus is a major detriment to the quality of life, well-being, and work productivity.

The causes of tinnitus are complex and related to noise exposure, life stress, hearing loss, otologic disorders, and hyperacusis, among others.<sup>3</sup> One of the prevailing hypotheses on the causes of tinnitus is the top-down or bottom-up theory of auditory attention. Theoretically, the auditory perception of tinnitus originates from the loss of sensory input from the cochlea to the auditory thalamus (bottom-up generation) and/or the reorganization of key neural networks responsible for attention, emotion, and hearing (top-down modifiers).<sup>4</sup> Therefore, the increased irritating nature of tinnitus over time may be the result of long-lasting chronic abnormal auditory function in some patients. In recent years, with the development of imaging technology, differences in brain function between acute and chronic tinnitus have been gradually revealed, and a perfusion functional magnetic resonance imaging (fMRI) study has showed that cerebral blood flow (CBF) changes in some brain regions between acute and chronic tinnitus patients and that networks including cognition, attention, mood are related to the chronicity of tinnitus. Also, a recent ecological instantaneous assessment study has showed that the tinnitus distress level will fluctuate over time, and these fluctuations are related to emotional factors.<sup>5</sup> It appears that the pathogenesis of acute and chronic tinnitus is different, the treatment and management priorities for tinnitus at different stages should also be different; however, the exact clinical characteristics and psychoacoustic status of the chronization of tinnitus remain controversial.

Tinnitus is fairly heterogeneous in clinical symptoms and psychological states. Previous cross-sectional studies of tinnitus have focused on the relationship between severity and several factors including sleep disorders, gender, anxiety, and depression, audiological risk factors such as hearing problems and hyperacusis, different side, and so on.<sup>6</sup> However, the relationship between the clinical characteristics and psychoacoustic status and severity of acute and chronic tinnitus has not been well-studied.

Therefore, this study explored the differences in clinical characteristics and psychoacoustic status among tinnitus patients with different course, in order to explore the correlation between the course of disease and the clinical characteristics and severity of tinnitus, and provide a certain reference basis for the clinical management of acute and chronic tinnitus.

## 2 | MATERIALS AND METHODS

### 2.1 | Study population

We implemented this cross-sectional study in eight general hospitals from five districts of Shanghai, China, between January 2021 and January 2022 covered two hospitals in the Jingan District, two hospitals in the Pudong District, one hospital in the Changning District, one hospital in the Hongkou District, one hospital in the Baoshan District, and one hospital in the Songjiang District. We recruited subjective tinnitus patients with history greater than 1 month in the ear, nose and throat (ENT) clinic of these hospitals. This study was approved by the Ethics Committee of Shanghai Municipal Hospital of Traditional Chinese Medicine (2021SHL-KY-70), and the consent of patients and their families was obtained. The STROBE checklist for cross-sectional studies was used for reporting this study (Table S1).

Inclusion criteria were as follows: (i) Tinnitus as the primary complaint; (ii) Age 18–80 years; (iii) Written informed consent signed by patients and their families. Exclusion criteria included (i) Objective tinnitus; (ii) Tinnitus caused by nonotogenic factors such as endocrine, blood and other factors; (iii) Tinnitus caused by head and ear trauma; (iv) Difficulty in communication, or with a history of serious mental illness, unable to complete follow-up.

### 2.2 | Sample size

G\*Power 3.1.9.7 program was used to calculate the sample size, with a linear multiple regression model. The statistical significance level was set at  $\alpha = 0.05$ , the effect size of 0.1, the statistical power ( $1-\beta$ ) of 0.95, and total predictor numbers of 16. Theoretically, a minimum sample size of 133 was calculated.

### 2.3 | Questionnaires

Otolaryngologists evaluated and collected general information (gender, age, family history), clinical symptoms of patients, including tinnitus duration, localization of tinnitus, and so forth. All patients completed questionnaires, psychoacoustic measurements, pure tone audiometry, and tinnitus matching. Pure tone audiometry and tinnitus matching were measured and evaluated by an experienced audiologist.

#### 2.3.1 | Tinnitus severity and psychological status

The tinnitus severity and psychological status of patients were evaluated with the Tinnitus Handicap Index (THI), the Tinnitus Evaluation

Questionnaire (TEQ) and the Tinnitus Disturbance Visual Assessment Scale (VAS). The Chinese-Mandarin version of the THI has a high test-retest ( $r = 0.98$ ) and internal consistency reliability ( $\alpha = 0.93$ ).<sup>7</sup> TEQ is a Mandarin version of the tinnitus evaluation scale consisting of six questions, with a total score of 21 points: 1–6 (Grade I), 7–10 (Grade II), 11–14 (Grade III), 15–18 (Grade IV), 19–21 (Grade V). The TEQ shows an excellent inter-rater reliability, a good internal consistency reliability, an acceptable convergent validity and is more operational with less time required.<sup>8,9</sup> The VAS for tinnitus annoyance has a total score of 10. The patient can judge the annoyance of tinnitus by himself. There is a positive correlation between the score and the severity of irritability.

### 2.3.2 | Mental health

Symptoms of anxiety and depression were measured with the Hospital Anxiety and Depression Scale (HADS). This is a 14-item questionnaire that uses a four-point scale to measure symptoms of anxiety (HADS-A; 7 items) and depression (HADS-D; 7 items). Each item is scored on a scale of 0–3. There is a positive correlation between the score and the severity of anxiety or depression. The total scores for the anxiety and depression scales range from 0 to 21. A score of  $\geq 8$  indicates a possible depression or anxiety.<sup>10,11</sup>

### 2.3.3 | Pittsburgh Sleep Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is a self-reported measure to assess the sleep quality of an individual. It is made-up of 19 individual items that measure seven domains.<sup>12</sup> The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality.

## 2.4 | Audiological examination

Pure tone audiometry was tested by an experienced audiologist using the Danish Audio Traveler AA222 audiometer and the Danish international listening Titan platform. The frequency of hearing thresholds ranged from 0.25 to 8 kHz in all patients, and patients whose tympanometry was type B or C were excluded. For patients with bilateral tinnitus, the obvious side was used as the test ear. According to the frequency of hearing loss, 0.25–0.5 kHz is low frequency hearing loss, 1–3 kHz is medium frequency hearing loss, and 4–8 kHz is high frequency hearing loss.

## 2.5 | Tinnitus matching

Tinnitus matching was similarly performed by an experienced audiologist using the TinniTest comprehensive diagnosis and treatment instrument (TTS-1000A) produced by Sichuan Weidi Digital Co., Ltd. Tinnitus tone types included pure tone, narrowband noise and white

noise, the main tone frequency was matched with pure tone between 0.125 and 8 kHz, and the nontest ear was stimulated for matching. The frequency of tinnitus was refined to 1/24 octave. Loudness matching was performed using tones of the same frequency as the tinnitus tone, with results accurate to 1 dB.

## 2.6 | Statistical analysis

Data analysis were performed with SPSS 22.0 and GraphPad Prism 8.0.2. We described the data by using frequency counts and proportions (percentage) for categorical variables, mean, and standard deviation (SD) for quantitative variables. Categorical variables were analyzed by the  $\chi^2$  or Fisher's tests. One way ANOVA, Mann-Whitney U test, and Kruskal-Wallis test were used for analysis of quantitative variables. We applied multivariate ordinal logistic regression analysis to calculate odds ratios (ORs) and 95% confidence interval (95% CI) to explore the association between the course of disease and the clinical characteristics and severity of tinnitus. A two-tailed  $p < .05$  was considered statistically significant.

## 3 | RESULTS

### 3.1 | Demographics, tinnitus characteristics, and psychopathological status of patients

Our study included 359 patients, 155 of whom were male and 204 were female. A total of 126 patients suffered from acute tinnitus ( $<3$  month), 58 had subacute tinnitus (3–6 months), and 175 had chronic tinnitus ( $>6$  months). The age of the patients ranged from 18 to 80 years, with an average of  $52.24 \pm 16.58$  years in acute tinnitus, an average of  $51.31 \pm 15.00$  years in subacute tinnitus, and an average of  $52.93 \pm 14.97$  years in chronic tinnitus. Of all tinnitus patients, 15.32% were smokers and 12.26% were drinkers. Hearing loss was reported as follows: mild hearing loss for 118 patients, moderate hearing loss for 76 patients, and severe hearing loss for 35 patients, hearing loss frequency occurred at low-mid frequency in 14.48% of patients, high frequency in 26.18%, and all frequency in 23.12%. Tinnitus frequency occurred at low-mid frequency in 55.2% of patients; high frequency in 44.8%. The mean tinnitus loudness was  $12.83 \pm 8.73$  dB in acute tinnitus,  $14.64 \pm 10.79$  dB in subacute tinnitus,  $13.97 \pm 9.24$  dB in chronic tinnitus. According to THI score, tinnitus severity was divided into five levels, of which level 1 accounted for 31.75%, level 2 accounted for 39.83%, level 3 accounted for 16.16%, level 4 accounted for 10.03%, and level 5 accounted for 2.23% (Table 1).

### 3.2 | Relationship between the course of tinnitus and different characteristics

The distribution of the course of tinnitus differed by tinnitus side, hearing loss frequency, tinnitus frequency, tinnitus severity (THI, TEQ,

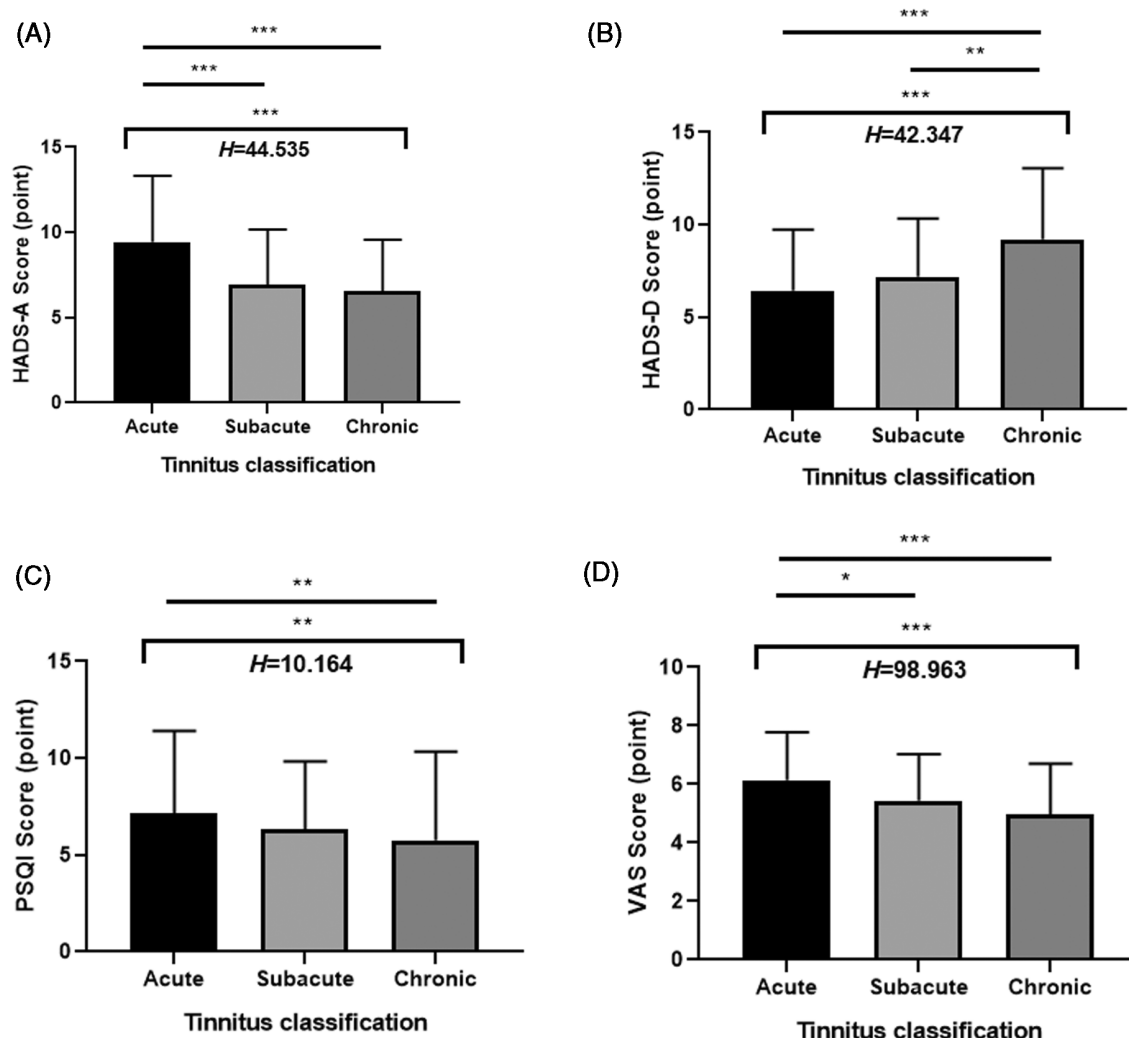
**TABLE 1** Clinical characteristics of patients with tinnitus and the relationship between the course of tinnitus and different characteristics ( $n = 359$ )

		Acute	Subacute	Chronic	$\chi^2/F$	$p$
Gender	Male	56	28	71	1.181	0.554
	Female	70	30	104		
Age (years)		52.24 $\pm$ 16.58	51.31 $\pm$ 15.00	52.93 $\pm$ 14.97	0.250	0.779
Side	Unilateral	76	39	76	13.868	<b>0.001</b>
	Bilateral	50	19	99		
State	Persistent	80	35	124	2.992	0.224
	Intermittent	46	23	51		
Smoking		17	7	31	1.570	0.456
Drinking		15	8	21	0.153	0.927
Hearing loss (dB HL)	Normal	41	21	68	3.920	0.688
	Mild	47	21	50		
	Moderate	28	10	38		
	Severe	10	6	19		
Total hearing loss rate (%)		67.46	63.79	61.14		
Frequency (Hz)	Normal	41 <sup>a***</sup>	2	68	33.642	<b>0.000</b>
	Low-mid frequency	28 <sup>a***</sup>	9	15		
	High frequency	17 <sup>a***</sup>	13	64		
	All frequency	40 <sup>a***</sup>	15	28		
Tinnitus frequency (Hz)	Low-mid frequency	74 <sup>a*</sup>	44 <sup>a***</sup>	80	17.012	<b>0.000</b>
	High frequency	52 <sup>a*</sup>	14 <sup>a***</sup>	95		
Tinnitus loudness (dB)		12.83 $\pm$ 8.73	14.64 $\pm$ 10.79	13.97 $\pm$ 9.24	1.480	0.477
THI	1	26 (20.6%) <sup>a***</sup>	19 (32.8%)	69 (39.4%)	53.450	<b>0.000</b>
	2	37 (29.4%) <sup>a***</sup>	30 (51.7%)	76 (43.4%)		
	3	30 (23.8%) <sup>a***</sup>	8 (13.8%)	20 (11.4%)		
	4	26 (20.6%) <sup>a***</sup>	1 (1.7%)	9 (5.1%)		
	5	7 (5.6%) <sup>a***</sup>	0 (0.0%) <sup>a</sup>	1 (0.6%)		
TEQ	1	14 (11.1%) <sup>a**</sup>	7 (12.1%) <sup>a*</sup>	35 (20.0%)	29.215	<b>0.000</b>
	2	34 (27.0%) <sup>a**</sup>	17 (29.3%) <sup>a*</sup>	69 (39.4%)		
	3	45 (35.7%) <sup>a**</sup>	30 (51.7%) <sup>a*</sup>	51 (29.1%)		
	4	32 (25.4%) <sup>a**</sup>	4 (6.9%) <sup>a*</sup>	18 (10.3%)		
	5	1 (0.8%) <sup>a**</sup>	0 (0.0%) <sup>a*</sup>	2 (1.1%)		
HADS-A	Normal (<11)	94 (74.6%) <sup>a***</sup>	48 (82.8%) <sup>a**</sup>	154 (88.0%)	9.091	<b>0.011</b>
	Anxious ( $\geq 11$ )	32 (25.4%) <sup>a***</sup>	10 (17.2%) <sup>a**</sup>	21 (12.0%)		
HADS-D	Normal (<11)	106 (84.1%) <sup>a***</sup>	49 (84.5%) <sup>a***</sup>	129 (73.7%)	6.015	<b>0.049</b>
	Depression ( $\geq 11$ )	20 (15.9%) <sup>a***</sup>	9 (15.5%) <sup>a***</sup>	46 (26.3%)		
PSQI	Normal ( $\leq 5$ )	68 (54.0%) <sup>a**</sup>	34 (58.6%)	120 (68.6%)	6.923	<b>0.031</b>
	Sleep disorder ( $> 5$ )	58 (46.0%) <sup>a**</sup>	24 (41.4%)	55 (31.4%)		

Note: It was statistically significant compared with chronic tinnitus, \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ . Statistically, significant  $p$ -value associations are shown in bold characters.

VAS), anxiety severity (HADS-A), depression severity (HADS-D), and sleep disorders severity (PSQI) (Table 1). Specifically, patients with chronic tinnitus were more likely to have hearing loss in the high frequency, and tinnitus frequency was similarly predominant in the high frequencies. In terms of tinnitus severity, patients with acute tinnitus were somewhat more severe than chronic patients. Relatively, patients with acute tinnitus were more likely to have concomitant

anxiety (Figure 1A, Table 1), whereas those with chronic tinnitus were more likely to be depressed (Figure 1B, Table 1). In terms of sleep, the three groups of patients showed statistical differences, with acute tinnitus patients likely to be worse sleepers, but the PSQI scores of the three groups did not have significant difference (Figure 1C, Table 1). VAS scores showed a trend that was generally consistent with the PSQI (Figure 1D, Table 1). In addition, there were no statistically



**FIGURE 1** The relationship between the course of tinnitus and HADS-A (A), HADS-D (B), PSQI (C), and VAS scores (D). \* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$ .  $H$  represents the test statistic for Kruskal-Wallis test

significant differences in gender, age, tinnitus status, smoking, drinking, hearing loss, or between the loudness of tinnitus and the duration of tinnitus in all patients.

### 3.3 | Multivariate ordinal logistic regression analysis for characteristics associated with the course of tinnitus

The different characteristics were included in the multivariate ordinal logistic regression analysis. As tinnitus progressed, persistent tinnitus state (OR = 2.00,  $p = .008$ ), high frequency hearing loss (OR = 4.77,  $p < .001$ ), depression severity (HADS-D, OR = 1.23,  $p < .001$ ) were found to be positively associated with the course of tinnitus. On the contrary, unilateral tinnitus (OR = 0.48,  $p = .003$ ), mild (OR = 0.29,  $p = .001$ ) and moderate (OR = 0.46,  $p = .038$ ) hearing loss, VAS scores (OR = 0.82,  $p = .032$ ), anxiety severity (HADS-A, OR = 0.81,  $p < .001$ ), THI scores (OR = 0.98,  $p = .002$ ), sleep disorders severity

(PSQI, OR = 0.94,  $p = .025$ ) were found to be negatively associated with the course of tinnitus (Table 2).

## 4 | DISCUSSION

Tinnitus is a heterogeneous condition with considerable variations in onset, associated with anxiety, depression, stress, cognitive impairment, and sleep disorders. To our knowledge, the etiology of tinnitus and objective means of measuring it are still undiscovered. Among reported risk factors and comorbidities of tinnitus, hearing loss, poor sleep, and mental functions are conditions, which cannot be dismissed. Numerous previous studies have linked chronic tinnitus to a vicious cycle of anxiety, depression, and sleep disorders,<sup>13</sup> but evidence of change over time is lacking. Therefore, we explored for the first time the relationship between sleep disturbance, anxiety, depression, and tinnitus duration in patients with acute and chronic tinnitus in Shanghai, China. We found the distribution of the course of tinnitus

**TABLE 2** Multivariate ordinal logistic regression results for characteristics associated with the course of tinnitus

Variables	$\beta$	S.E.	Wals	<i>p</i>	OR	95% CI	
Age	0.002	0.008	0.069	0.793	1.01	−0.01	0.02
Gender (vs. female)	−0.322	0.248	1.695	0.193	0.73	−0.81	0.16
Smoking	−0.408	0.342	1.421	0.233	0.67	−1.08	0.26
Drinking	0.377	0.369	1.048	0.306	1.46	−0.35	1.10
State (vs. intermittent)	0.691	0.261	6.989	<b>0.008</b>	2.00	0.18	1.20
Side (vs. bilateral)	−0.732	0.249	8.660	<b>0.003</b>	0.48	−1.22	−0.24
Hearing loss (vs. normal)							
Mild	−1.257	0.393	10.217	<b>0.001</b>	0.29	−2.03	−0.49
Moderate	−0.782	0.377	4.314	<b>0.038</b>	0.46	−1.52	−0.04
Severe	−0.426	0.449	0.901	0.342	0.65	−1.31	0.45
Hearing loss frequency (vs. normal)							
Low-mid frequency	0.169	0.424	0.159	0.690	1.18	−0.66	1.00
High frequency	1.563	0.395	15.678	<b>0.000</b>	4.77	0.79	2.34
Tinnitus frequency (vs. High frequency)	0.172	0.256	0.451	0.502	1.19	−0.33	0.67
Tinnitus loudness	0.007	0.013	0.309	0.578	1.01	−0.02	0.03
VAS	−0.197	0.091	4.624	<b>0.032</b>	0.82	−0.38	−0.02
HADS-A	−0.214	0.038	31.009	<b>0.000</b>	0.81	−0.29	−0.14
HADS-D	0.207	0.039	28.135	<b>0.000</b>	1.23	0.13	0.28
PSQI	−0.064	0.029	5.025	<b>0.025</b>	0.94	−0.12	−0.01
TEQ	−0.044	0.040	1.174	0.279	0.96	−0.12	0.04
THI	−0.024	0.008	9.321	<b>0.002</b>	0.98	−0.04	−0.01

Statistically, significant *p*-value associations are shown in bold characters.

differed by tinnitus side, hearing loss frequency, tinnitus frequency, tinnitus severity, anxiety severity, depression severity, and sleep disorders severity. We also found positive correlation between tinnitus course and persistent tinnitus state, high frequency hearing loss, and depression severity, indicating that the longer the course of tinnitus, the greater the likelihood of persistent tinnitus, high frequency hearing loss, and depression. Tinnitus course was negatively correlated with unilateral tinnitus, mild and moderate hearing loss, VAS scores, THI scores, anxiety severity, and sleep disorders severity, indicating that the shorter the course of tinnitus, the greater the likelihood of unilateral tinnitus, mild to moderate hearing loss, severe tinnitus, anxiety, and severe sleep disorders. In comparison with others, the main novelty of our study may be that we were the first to suggest an association between demographic characteristics, sleep disturbances, anxiety, and depression and the course of tinnitus.

Studies have found that tinnitus lasts longer in patients with bilateral tinnitus.<sup>14,15</sup> Similar results were obtained in this study, bilateral tinnitus, and persistent tinnitus were more likely to occur as the course of tinnitus increased. Some patients may have originally developed unilateral tinnitus, later experiencing bilateral tinnitus, which may be triggered by stress, insomnia, and so on. Our results were not consistent with those of Lan et al,<sup>16</sup> who reported that there were no significant differences in the tinnitus laterality between acute and chronic tinnitus groups. This may be due to their small sample size, which focused on the difference of brain function. To sum up, with the course advancing, persistent bilateral tinnitus apparently increased

the willingness to seek medical attention. However, the efficacy was often unsatisfactory in patients with chronic tinnitus, which eventually further triggered negative emotions such as frustration and disappointment.

The acute tinnitus patients in our study were more likely to be accompanied by mild to moderate, low, to mid frequency hearing loss. Correspondingly, high frequency hearing loss was more likely to occur as the course of tinnitus progresses, suggesting that the frequency of hearing loss may differ between acute and chronic tinnitus. A possible explanation was that the mechanism of acute tinnitus usually associated with cochlear damage, manifesting as hearing loss.<sup>17</sup> Decreased signal transduction in the cochlea reduces lateral inhibition of brain-stem auditory pathways, such as the dorsal nucleus of the cochlear nerve and the hypothalamus, leading to overactivation of auditory neurons around the frequency of hearing loss.<sup>18,19</sup> This might explain why the frequency of tinnitus is low to moderate in most patients with acute tinnitus. Similarly, the findings of Henry et al<sup>20</sup> concerning the acute tinnitus were similar to those in our patients. In addition, tinnitus is closely associated with the state of the peripheral nervous system and hair cells of the body. Many early tinnitus patients with normal pure tone audiometry may be in the early hair cell damage, pure tone audiometry cannot be reflected. With the prolongation of the course of tinnitus, the damage of inner ear hair cells leads to the decrease of high frequency hearing.

This study found more severe tinnitus severity and anxiety in patients with acute tinnitus. The relationship between disease course



and severity of tinnitus has long been ambiguous and controversial.<sup>21</sup> Chen et al<sup>22</sup> reported that tinnitus severity was positively correlated with sleep disturbance and anxiety, besides that Xu et al<sup>23</sup> reported that acute course was also correlated with tinnitus severity. These studies were consistent with our results. In contrast, Lan et al<sup>16</sup> reported no difference in the severity of acute and chronic tinnitus. Significantly, due to the different sample size, evaluation method and so on, there were differences in the results. Nonetheless, it was undeniable that tinnitus of different duration did cause different degrees of psychological impact to patients. In this study, patients with acute, subacute, and chronic tinnitus had different anxiety status. Tinnitus patients with short course were more likely to be accompanied by anxiety, which may be due to the high degree of attention to tinnitus, poor adaptability, tinnitus on the generation, outcome, and prognosis are unknown, therefore, more likely to be associated with anxiety. And chronic tinnitus patients in the long-term adaptation process, anxiety could be relieved. In our study, the longer the course of tinnitus, the more likely to be accompanied by depressive symptoms. Probably because patients with tinnitus cannot be cured for a long time, tinnitus signal activates the limbic system, which not only enhances the limbic system to the tinnitus signal perception and attention, but also leads to a more depressed mood.<sup>24</sup> This could explain a lot of clinical patients with chronic tinnitus often suffer from insomnia, panic, depression, and other negative emotions.

Among reported risk factors and comorbidities of tinnitus, sleep disturbance is a condition, which cannot be dismissed, as adequate sleep helps maintain individuals' normal physical and mental functions. Jia et al<sup>25</sup> reported that 46.4% of tinnitus patients were accompanied by insomnia. As an abnormal electrical signal produced by auditory cortex, tinnitus can be eliminated from the structure of central network in sleep state, when the cleaning function of the glial lymphatic system fails, metabolic waste products accumulate in the brain, affecting brain function and causing compensatory impairment of tinnitus.<sup>26-28</sup> Another recent study demonstrated that sleep improvement was associated with improvement in anxiety status, further suggesting that sleep disturbance in tinnitus patients may be related to anxiety.<sup>29</sup> Our study further demonstrated the conclusion, which showed that patients with a shorter course of tinnitus were more likely to have anxiety, more severe sleep disturbances, and more severe tinnitus. This prompted the importance of proper counseling education of patients as well as psychological guidance during the initial stage of the disease.

Since this is a cross-sectional study and the findings do not allow drawing causal conclusions about tinnitus, anxiety, and depression, part of the causality in the current study could only be speculated on. Therefore, more extensive longitudinal studies are needed to determine the psychological profiles and mechanisms of impact of tinnitus patients. And future studies should focus on the mutual mechanisms of tinnitus, anxiety, and sleep disorders and ask the exact pathogenesis of anxiety and depression in tinnitus patients and the general population. Nevertheless, our study demonstrated that tinnitus patients with different courses may have different tinnitus

characteristics and still provided a basis for clinical research on the diagnosis and treatment of tinnitus.

## 5 | CONCLUSION

In conclusion, patients with acute and chronic tinnitus differed in clinical symptoms, severity of tinnitus, and psychological status. Patients with acute tinnitus were more likely to have concomitant anxious mood, more severe tinnitus, and worse sleep. Patients with chronic tinnitus were more likely to have bilateral persistent high frequency tinnitus, and were at greater risk for depression. This may shed new light on clinical decision making in tinnitus.

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## CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

## DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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