

# **A Comparison of the Severity of Tinnitus in Patients with and without Hearing Loss Using the Tinnitus Functional Index (TFI)**

**Nadeem Mahafza<sup>1</sup>, Fei Zhao<sup>1,2\*</sup>, Amr El Refaie<sup>3</sup> and Feifan Chen<sup>1</sup>**

1. *Centre for Speech and Language Therapy and Hearing Science, Cardiff School of Sport and Health Sciences, Cardiff Metropolitan University, UK*
2. *Department of Hearing and Speech Science, Xinhua College, Sun Yat-Sen University, Guangzhou, China*
3. *Speech and Hearing Sciences, University College Cork, Ireland*

**\*Address for Correspondence :     Dr Fei Zhao**

**Centre for Speech Language Therapy and Hearing  
Science,  
Cardiff School of Health Sciences,  
Cardiff Metropolitan University,  
Llandaff Campus,  
200 Western Avenue, Cardiff CF5 2YB,  
United Kingdom**

**Phone: +44 (0)29 2041 7290**

**E-mail: fzhao@cardiffmet.ac.uk**

**Running title: Severity of Tinnitus Measured Using a Tinnitus Functional Index**

## **Abstract**

**Background:** Tinnitus is a disturbing symptom present in approximately 15% of the world population and between 2-7% of tinnitus sufferers seek medical help because of the chronic distress caused. Although well established that tinnitus can be present with and without hearing loss the different characteristics in terms of severity are still not completely known and studied. **Aim:** The objective of this study was to compare the severity of tinnitus in tinnitus patients with and without hearing loss. **Materials and Methods:** 73 tinnitus patients were included in this study at an audiology clinic in Amman, Jordan. Participants were assigned to two groups according to hearing status. The severity of tinnitus was evaluated using the Tinnitus Functional Index questionnaire. All participants were interviewed, followed by otoscopic examination, pure tone audiometry and tests for admittance and tinnitus matching. **Results:** The normal hearing group included 34 participants (46.6%) whose TFI scores were divided as follow: mild annoyance (17), significant annoyance (14) and severe annoyance (3). The sensorineural loss group included 39 participants (53.4%) with mild annoyance (11), significant annoyance (12) and severe annoyance (16). A statistically significant association was found between hearing status and the severity of tinnitus using a Chi Squared test ( $\chi^2=0.487$ ,  $p=0.007$ ). There was no association between tinnitus severity and age or gender. **Conclusion:** Tinnitus severity was significantly worse in tinnitus patients with a hearing loss than tinnitus patients with normal hearing thresholds. This should be taken in consideration when clinicians are planning counselling and management protocols for individual patients.

**Key Words: Tinnitus Functional Index Questionnaire (TFI), Severity, Hearing Loss, Normal Hearing Threshold,**

## Introduction

Tinnitus can be defined as a perception of sound in the absence of an external acoustic stimulus (Heller, 2003). Subjective chronic tinnitus is a bothersome condition that is widespread among the general population, with an estimated prevalence of 10-15% in adults (Henry et al., 2005). Because of its annoying nature, tinnitus can cause health related problems, such as disturbance of sleep, hindrance of concentration, together with possible anxiety and depression (Cima et al., 2011; Hébert et al., 2017; Langguth et al., 2011; Pilgramm et al., 1999). According to Davies et al. (1995), 2–7 % of tinnitus sufferers seek medical advice and intervention for their severe persistent tinnitus and its related symptoms that significantly affect daily life (McCombe et al., 1999; Bhatt et al., 2017; Schecklmann et al., 2015).

It is generally accepted that the perceived severity of tinnitus is influenced not only by the annoying sound itself, but also by the associated symptoms such as tinnitus-related stress, anxiety, depression, and insomnia (Folmer et al., 1999; Udipi et al., 2013). Bhatt et al. (2016) reported that 26.1% of approximately 21 million self-reported tinnitus sufferers had anxiety issues related to their tinnitus. Harrop-Griffiths et al. (1987) found that depression was an issue during their lifetime for 62% of their sample, i.e., 13 out of 21 tinnitus patients. Insomnia was reported as a concern for up to 76% of 182 tinnitus sufferers in the study by Schecklmann et al. (2015). Such severe bothersome complications can cause negative effects on quality of life, leading to suicidal thoughts or actions in the most extreme cases. In ENT/Audiology clinics, tinnitus severity is commonly assessed using psychoacoustic measurements, e.g., a tinnitus matching test and tinnitus residual inhibition test, together with self-reporting questionnaires that can be structured or open-ended. These tinnitus questionnaires are considered an essential tool in the measurement of tinnitus severity and

intervention-related outcomes. A recent review identified 24 tinnitus-related questionnaires used to examine the different domains in measuring the tinnitus percept, impact of tinnitus and outcomes of tinnitus intervention (Hall et al., 2016). Most of these questionnaires (34 %) assess the multiple attributes of the impact of tinnitus, with tinnitus loudness being the feature most often reported (14 %), followed by tinnitus-induced distress (7 %).

There is a broad diversity in domains used to measure tinnitus severity and intervention outcomes. The Tinnitus Handicap Inventory (THI) for example is used world-wide (15 %) to quantify the functional, emotional, and distressing impacts of tinnitus (Newman et al., 1998). The Tinnitus Reaction Questionnaire (TRQ) specifically assesses tinnitus-associated psychological / emotional components, including distress, interference, severity, and avoidance (Wilson et al., 1991), while the Tinnitus Handicap Questionnaire (THQ) mainly measures the patient's hearing ability and some social consequences of tinnitus (Kuk et al., 1990). There are however still issues with existing tinnitus questionnaires. For example, some questionnaires have uneven weighting across the different aspects of tinnitus, with only a small proportion evaluating the functional impact of tinnitus. Others are considered to focus too much on the areas of participation restriction and psychological aspects, without adequately describing the domains of predicting therapeutic benefit (Hall et al., 2016; Meikle et al., 2012).

The Tinnitus Functional Index (TFI) developed by Meikle et al. in 2012 provides a reliable and valid measurement of the multiple domains of tinnitus severity and intervention outcomes. The most important advantages of the TFI are its comprehensive coverage of many important tinnitus complaints, whose scores lead to a reliable categorisation of tinnitus severity, as well as assess responsiveness to treatment-related change (Fackrell et al., 2016). Moreover, the TFI shows high convergent validity against the THI and THQ, i.e. it appears to be measuring tinnitus handicap. It also shows moderate discriminant validity against general depression, anxiety and quality of life questionnaires, i.e., it is measuring some aspects that generic health domain questionnaires do not (Meng et al., 2016). In recent years, the TFI has been used clinically and is the second most commonly used tinnitus questionnaire in the United Kingdom National Health Service (NHS) (Hoare et al., 2015). A recent review conducted by Henry et al. (2016) provides up to date information on the TFI in terms of development, validation, outcomes research, and clinical application. Further evidence suggests that the TFI improves on certain domains of the psychometric properties essential for clinical diagnosis in terms of tinnitus severity and for outcome measurement in terms of intervention-related change (Fackrell et al., 2016; 2018). However, more clinical trials are needed to evaluate its sensitivity and validity in a more 'representative' heterogeneous clinical population. More work is also needed to gain a better understanding of the characteristics and patterns on subgroups of tinnitus patients with different severity. In this way, it would then provide useful information in planning an appropriate intervention scheme that meets individual needs.

Tinnitus is caused by diverse pathologies and is commonly associated with sensorineural hearing loss (Davies et al., 1995; McCombe et al., 1999). However approximately 10% of patients with a primary tinnitus complaint have normal hearing thresholds measured with

pure tone audiometry. Evidence shows that cochlear damage can be present in tinnitus patients with normal hearing thresholds before gross behavioral threshold reductions can be measured (Meikle et al., 2008). Although the association between hearing status and the severity of tinnitus has been investigated in many studies, the influence of hearing status on the severity of tinnitus remains uncertain. Therefore, in the present study the overall aim was to compare the severity of tinnitus experienced by tinnitus patients with and without hearing loss using the TFI questionnaire as well as analysing the specific characteristics of the TFI and its influencing factors. To our best knowledge, the present study is the first tinnitus study using an Arabic version of the TFI.

## **Materials and Methods**

### ***Participants***

73 patients with a primary tinnitus complaint were recruited in the Hearing Tec Audiology Clinic in Amman, Jordan. Inclusion and exclusion criteria were as follows:

- Patients had sought clinical help for their chronic tinnitus problem, which had lasted more than 6 months;
- Age was between 18 and 50 years in order to match demographic factors;
- Patients were able to complete the Tinnitus Functional Index questionnaire in the Arabic language (Appendix I) by themselves or with the help of a significant other;
- Patients with conductive or mixed hearing loss were excluded;
- Patients had no history of use of ototoxic drugs;
- Patients had no history of intracranial surgery or severe brain injury, tumour and auditory phantoms secondary to Meniere's disease or psychiatric disease;

There were 37 males and 36 females in total, aged between 18-50 years. Participants were assigned to two groups on the basis of their hearing ability:-

- Group 1: patients with tinnitus with hearing thresholds audiometrically within 'normal limits', defined as  $\leq 20$  dB HL at each octave frequency from 500 to 4,000 Hz in the poorer ear, with no hearing level at any frequency between 250 and 8,000 Hz exceeding 30 dB HL (Zhao et al., 2014);
- Group 2: patients with tinnitus with mild to moderate sensorineural hearing loss defined as  $> 20$  dB HL at each octave frequency from 500 to 4,000 Hz in the better ear. The main concern for these patients was their tinnitus, not their hearing loss. As a consequence, they were not fitted with hearing aids when they participated in the present study.

This study was approved by the ethics committee of the Health Care and Food Ethics Panel, Cardiff School of Sport and Health Sciences, Cardiff Metropolitan (Project Reference Number PGT-101).

### ***Procedure of Audiological Investigations***

All participants were interviewed to obtain a thorough case history including; age, duration of tinnitus, side of tinnitus, previous interventions and any other pathologies. This was followed by an otoscopic examination, pure tone audiometry, an admittance test and tinnitus match test using the following methodologies:-

- ***Threshold determination:*** Pure tone hearing thresholds were measured in both ears at frequencies between 250Hz and 8,000 Hz, using a calibrated Interacoustics AA222 audiometer and TDH-39 earphones. The procedure used was that recommended by the British Society of Audiology.



- ***Tympanometry:*** An Interacoustics Titan Tympanometer was used to assess middle ear function.
- ***Tinnitus Pitch and loudness matching tests:*** Participants with unilateral tinnitus had the ear with tinnitus tested. Participants with bilateral tinnitus where tinnitus loudness was similar in both ears had the right ear tested. Participants with bilateral tinnitus with different tinnitus loudness between ears were tested on the ear with the loudest tinnitus. Tested frequencies ranged from 125 Hz to 8000 Hz and a bracketing procedure (starting from 1000 Hz) was used for pitch matching. The participants were instructed to indicate whether the pitch was higher or lower than their tinnitus pitch. If the participant reported the pitch to be lower than that presented a tone was presented half an octave lower. The procedure was stopped when the tinnitus pitch was matched. An octave confusion test was conducted to confirm the tinnitus frequency (Prabhu and Chandan, 2014).  
  
Loudness of tinnitus was estimated at the same frequency at which the pitch was matched. The same procedure employed in the pitch matching was used to decide the test ear when testing tinnitus loudness. The test tone was lower than the participant's hearing threshold and only an ascending series of intensity levels was employed to minimize residual inhibition. The sound level presented to the participant was increased in small steps (1dB) until the participant confirmed that the external tone was about equal to the loudness of their tinnitus (Prabhu and Chandan, 2014).

### ***Tinnitus Functional Index***

In the present study, a validated TFI in the Arabic language provided by Oregon Health and Science University was used. The TFI had 25 questions in total including eight subscales

addressing; tinnitus intrusiveness, the sense of control, cognitive interference, sleep disturbance, auditory issues associated with tinnitus presence, relaxation issues, quality of life, and emotional distress.

Overall score was determined from the sum of all the valid answers (maximum possible score = 250 if the participant were to rate all 25 TFI items at the maximum value of 10), divided by the number of questions for which that participant provided valid answers (yields the respondent's mean item score for all items having valid answers) and then multiplied by 10 (provides that respondent's overall TFI score within 0-100 range). Severity of tinnitus was placed into three categories on the basis of the total score;

- (1) Mild annoyance, total score less than 25, little or no intervention required.
- (2) Significant annoyance, total score between 25 and 50, possible need for professional intervention.
- (3) Severe annoyance, total score greater than 50, tinnitus severe enough to qualify for more aggressive intervention (Henry et al., 2016).

### ***Statistical Analysis***

Data analysis was performed using SPSS Statistics (ver.25 for IOS). A Chi-Squared test, an independent sample *t*-test and analysis of variance (ANOVA) were undertaken. The level of significance was set at the conventional 5% level in each case.

## **Results**

- **General Information on Tinnitus Patients in Both Groups**

73 participants were included in the present study. 34 (46.6%) suffered from tinnitus but had normal hearing thresholds (Group 1). 39 (53.4%) suffered from tinnitus with sensorineural hearing loss (Group 2). Table 1 summarizes the demographic data.

A Chi-squared test showed no statistically significant difference in gender between the two groups ( $\chi^2=0.34$ ,  $p=0.563$ ). An independent sample  $t$ -test showed no statistically significant difference in age between the two groups ( $t =2.13$ ,  $p=0.699$ ).

**Table 1.** Demographic information of tinnitus patients in normal hearing and sensorineural hearing loss groups.

	Normal Hearing Group		Sensorineural Hearing Loss Group	
Gender	Number of Participants (Percent)	Mean Age $\pm$ Standard Deviation	Number of Participants (Percent)	Mean Age $\pm$ Standard Deviation
Male	16 (47.1%)	35.8 $\pm$ 10.3	21 (53.8%)	40.0 $\pm$ 10.1
Female	18 (52.9%)	36.9 $\pm$ 9.2	18 (46.2%)	42.7 $\pm$ 9.2
Total	34 (100.0%)	36.4 $\pm$ 9.6	39 (100.0%)	41.3 $\pm$ 9.7

Figure 1 shows tinnitus pitch measurements for all participants over the frequency range between 250 and 8,000 Hz. In both groups there was a high percentage of participants who experienced high pitched tinnitus greater or equal to 2000 Hz, 94.1% of participants (32/34) in the normal hearing group and 89.7% (35/39) in the sensorineural hearing loss group. An independent sample  $t$ -test revealed no significant difference in tinnitus frequency between the two groups ( $t=0.102$ ,  $p=0.919$ ). Tinnitus loudness ranged from 5 dB SL to 27 dB SL in the normal hearing group, and 3 dB SL to 26 dB SL in the sensorineural hearing loss group. No significant difference in tinnitus loudness was found between the 2 groups using the independent sample  $t$  test ( $t=1.54$ ,  $p=0.489$ ).

**Figure1**

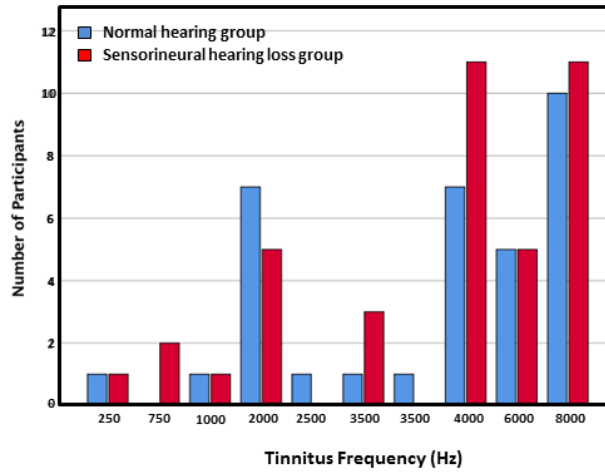


Figure 1 Distribution of tinnitus frequencies in the normal hearing and sensorineural hearing loss groups.

- **Severity Analysis with the Tinnitus Functional Index**

In the normal hearing group, the level of tinnitus annoyance was reported as mild by 17 participants, significant by 14 participants and severe by only 3. In contrast, in the sensorineural hearing loss group, tinnitus annoyance was reported as mild by 11, significant by 14, and 16 participants indicated severe annoyance (Table 2). The Chi-squared test showed a statistically significant association between hearing status and severity of tinnitus ( $\chi^2=0.487, p=0.007$ )

**Table 2.** Tinnitus severity for participants in the normal hearing and sensorineural hearing loss groups.

Severity of TFI	Normal Hearing Group		Sensorineural Hearing Loss Group	
	Number of participants (%)	Mean $\pm$ SD (dB HL)	Number of participants (%)	Mean $\pm$ SD (dB HL)
Mild	17 (50.0)	33.7 $\pm$ 9.6	11 (28.2)	43.4 $\pm$ 9.3
Significant	14 (41.2)	37.9 $\pm$ 9.4	12 (30.8)	41.8 $\pm$ 10.1
Severe	3 (8.8)	44.7 $\pm$ 4.9	16 (41.0)	39.3 $\pm$ 9.8

<b>Total</b>	<b>34 (100.0)</b>	<b>36.4 ± 9.6</b>	<b>39 (100.0)</b>	<b>41.3 ± 9.7</b>
--------------	-------------------	-------------------	-------------------	-------------------

A two-way ANOVA was conducted to examine the significance of the scores in the three severity categories of TFI between the groups. Results showed a statistically significant difference between the groups ( $F_{(2,70)}=5.58, p=0.006$ ). There was a statistically significant interaction between the three levels of the TFI scores ( $p=0.006$ ). Further Bonferroni post-hoc tests were performed that showed significant differences in the TFI scores between the mild and severe categories, as well as between the significant and severe categories ( $p=0.006$  and  $p= 0.029$ , respectively). However, participants who reported a mild level of annoyance on the TFI did not differ significantly from participants who scored a significant effect ( $p>0.05$ ).

The Chi- squared analysis of severity of each subscale between the different hearing status groups showed significant differences in; intrusiveness ( $\chi^2=16.94, p<0.0005$ ), sense of control ( $\chi^2=13.32, p=0.001$ ), sleep ( $\chi^2=6.91, p=0.032$ ), auditory subscale ( $\chi^2=15.46, p<0.0005$ ), relaxation ( $\chi^2=8.08, p=0.018$ ), and quality of life ( $\chi^2=7.46, p=0.024$ ). However, there were no significant differences in; severity of cognition ( $\chi^2=4.71, p=0.095$ ), and

emotional ( $\chi^2=5.14, p=0.076$ ) subscales.

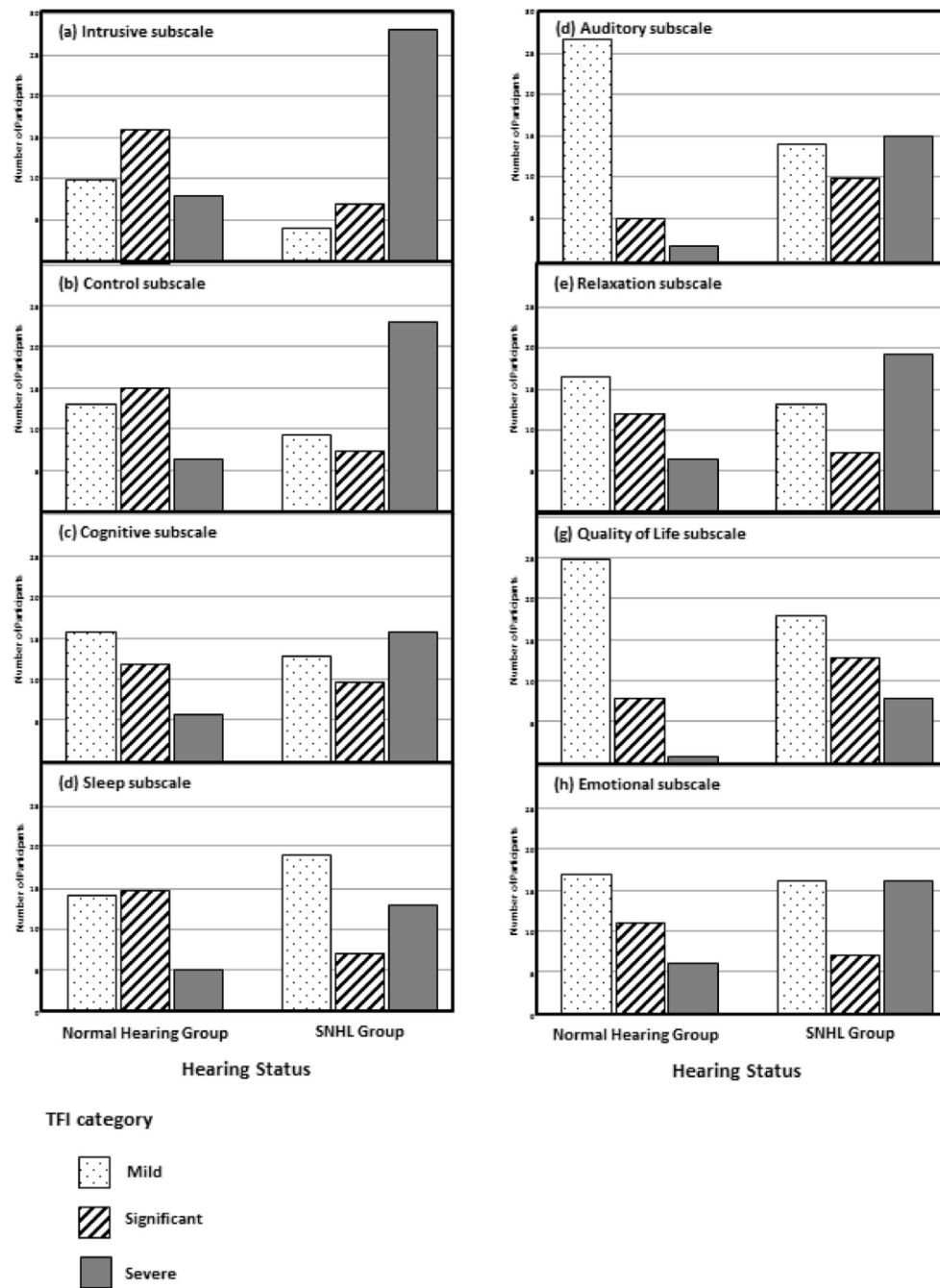


Figure 2 Comparisons of the TFI subscales scores in three different categories between normal hearing and sensorineural hearing loss groups.

## Discussion

The TFI is currently accepted as an effective tool for measuring the subjective severity and negative impact of tinnitus, as well as assessing treatment-related changes. It is noteworthy

however that the TFI is a subjective measure of tinnitus severity self-reported by individual patients. There is evidence to show that it differs from tinnitus severity determined using other methods, such as psychoacoustic measurements and several other studies have shown that THI scores did not correlate significantly with tinnitus loudness measurements (Zhao et al., 2019; Durai and Searchfield, 2017).

In this study, statistical analysis of the severity of annoyance using the TFI questionnaire showed that a significantly higher proportion of participants with sensorineural hearing loss were reporting severe annoyance. This indicates that hearing status is associated with severity of tinnitus, in keeping with previous findings using different outcome measures (e.g., Savastano, 2008; Axelsson and Ringdahl, 1989). Savastano (2008) investigated the clinical characteristics of tinnitus in normal hearing tinnitus patients and tinnitus patients with hearing loss using the THI. Their results showed that subjective discomfort was higher in the presence of hearing loss. In addition, significantly higher masking levels were required with hearing impaired subjects than with normal hearing subjects. As a result, the hearing impairment seems to increase the perceived severity of the symptom, indicating an association between subjective severity of tinnitus and hearing status. Axelsson and Ringdahl (1989) also suggest that tinnitus is more common and severe in tinnitus patients with hearing loss than in tinnitus patients with normal hearing.

Other studies demonstrate the influence of hearing loss on the severity of tinnitus using different tinnitus questionnaires, e.g., the Tinnitus Handicap Questionnaire (THQ) and Tinnitus Severity Index (TSI). The THQ mean scores correlated significantly with hearing thresholds at low frequencies obtained from the pure tone audiometry, indicating the impact of hearing loss on the severity of tinnitus. Such impact is likely due to a reduction in tinnitus masking effect provided by ambient low frequency sound, and consequently higher tinnitus

handicap occurs in association with tinnitus related anxiety and depression (Searchfield et al., 2007). Further evidence supports that tinnitus patients with clinically significant hearing loss have anxiety and depression as a reaction to hearing loss, which could affect the impact of tinnitus severity (Khilnani et al., 2018; McKinney et al., 1999)

In contrast, several studies did not show an effect of hearing loss on tinnitus severity (Savastano et al., 2008; Pinto et al., 2010). For example, the impact of hearing loss on tinnitus severity was studied by Searchfield et al. (2007). They used a Tinnitus Severity Index (TSI) to assess tinnitus severity and related the results with audiometric data taken in the clinic. They found no significant correlation between tinnitus severity and any of the variables obtained from the audiogram. In addition, a recent study by Pinto et al. (2010) found that demographic factors and hearing loss did not influence tinnitus annoyance when using the THI. These negative results are likely due to the sensitivity of the questionnaires, and/or a heterogeneous clinical population caused by the use of different inclusion criteria.

The other advantage of the TFI is that it provides useful domains directly relevant to ENT/Audiology clinics in terms of diagnosis, intervention and rehabilitation. The findings derived from the present study suggest that hearing status affects the subjective severity of the following subscales: intrusiveness, sense of control, sleep, audition, relaxation and quality of life. However, there were no statistically significant differences in severity of cognitive and emotional subscales in tinnitus patients with and without hearing loss. One possible explanation is that both cognitive and emotional subscales reflect a general aspect of tinnitus severity unaffected by hearing status. The reason underlying such discrepancy needs further investigation.

The psychometric properties and clinical performance of the TFI have been assessed in a large scale study of UK non-clinical and clinical populations (Fackrell et al., 2016; Fackrell et al.,



2018). Their conclusions indicate that the TFI covers multiple domains in the burden of tinnitus, and provides a reliable measure enabling identification of different levels of distress associated with tinnitus. However, the 'Auditory' subscale of the TFI did not contribute to the overall construct 'functional impact of tinnitus' in these studies. The authors suggest that a modified version of the TFI without the Auditory subscale (TFI-22) would be better in calculating a global composite score for the UK tinnitus population. In the present study, tinnitus subjects with sensorineural hearing loss scored significantly higher on the Auditory subscale of the TFI than tinnitus patients with normal hearing thresholds, indicating more hearing related issues occurred in tinnitus subjects with sensorineural hearing loss. Therefore, the auditory subscale of the TFI can be used as a sensitive factor and provides valuable information for identifying the specific characteristics of hearing difficulties in tinnitus patients with different hearing status, which is likely to impact on the severity of the tinnitus-related distress. The Tinnitus Reaction Questionnaire (TRQ) is a useful tool to evaluate the effect of tinnitus on patients psychological health and the ability to handle tinnitus-related distress, such as depression and anxiety (Wilson et al., 1991). AS a consequence the TRQ could be used to determine the severity of the tinnitus related distress in tinnitus patients with different hearing status alongside the TFI in future studies (Andersson et al., 2002; Kaldo et al., 2007; Malouff et al., 2010).

The detailed analysis of the TFI subscales provides clinicians with insight as to how to approach and manage tinnitus as a symptom in normal hearing individuals as well as sensorineural hearing loss patients. A recent study by Beukes (2018) addresses the importance of identifying the specific problematic situations tinnitus sufferers encountered in order to adopt different coping strategies. Their results indicated that two approaches, i.e., active strategies and passive strategies, were adopted by patients with tinnitus. People who

used passive coping strategies had significantly greater levels of tinnitus distress, anxiety, and depression in comparison to those who had habituated and used active coping strategies.

In the present study, the significant differences in severity of several TFI subscales highlight the specific problematic situations in tinnitus patients having different hearing status. The important implications derived from the results would facilitate further investigations into coping behaviours used in specific problematic situations and evaluation of the effectiveness of different coping strategies adopted by individuals to deal with their tinnitus.

The qualitative study by Dauman et al. (2017) suggests that tinnitus patients' narratives provided a better understanding of the comprehensive conditions by taking into account individual perspectives in terms of their perceptions under various circumstances. Their results revealed frustration as a central issue in patients with chronic tinnitus, caused mainly by lack of control over tinnitus presence and difficulties in the surrounding auditory environment. They suggest that person-centred counselling and psychotherapy management approaches should focus on key variables to ease individual frustration. In addition, another qualitative study by Marks et al. (2019) suggests that early interventions providing clear and realistic information about tinnitus and appropriate management strategies would help to reduce chronic tinnitus induced distress. Therefore, different intervention modalities could be used in the clinic setting according to the different tinnitus characteristics associated with different hearing status. For example, the elevation of severity of tinnitus in patients with mild to moderate sensorineural hearing loss could implicate the use of an appropriate management model, such as one that emphasises early amplification even if hearing loss is not the primary complaint, together with providing initial counselling and information on coping strategies (Searchfield et al., 2010).

Currently the TFI has been translated into many languages, e.g., Swedish, German, Polish, Chinese, Japanese and Arabic. Although the reliability and validity of the TFI in non-English versions is verified when compared to other self-report questionnaires, the TFI has not been widely used in a non-English speaking tinnitus clinical population. It would be interesting to conduct a cross cultural study using different language versions of the TFI to identify tinnitus severity in terms of various dimensions in the cultural context. This could provide a better understanding of tinnitus and its effect on patients with different hearing status in different socio-economic environments, and thus lead to more specific and effective intervention approaches with clearer strategies to implement in counselling and rehabilitation.

## **Conclusion**

Using the Tinnitus Functional Index, a significantly worse severity was perceived by tinnitus patients with mild to moderate sensorineural hearing loss than tinnitus patients with normal hearing thresholds. In addition, the subscales of the Tinnitus Functional Index showed that tinnitus patients suffering from sensorineural hearing loss had more persistent tinnitus, a reduced sense of control over their tinnitus, sleep disturbances, auditory difficulties attributed to tinnitus, difficulty relaxing and a reduced quality of life. However, no association was found between tinnitus severity and demographic factors.

As an important assessment tool for the international tinnitus community, it would be useful to further examine the TFI in a clinical population in different countries for a detailed diagnostic and intervention evaluation.

An investigation into the degree of sensorineural hearing loss associated with the severity of tinnitus would be essential to identify the precise characteristics of the tinnitus perception in order to facilitate improved tinnitus management and

audiological rehabilitation. Moreover, future studies on the impact of pre- and post- hearing aid intervention on the severity of tinnitus using TFI in tinnitus patients with sensorineural hearing loss will also provide significant clinical implications.

### **Acknowledgements**

We would like to thank the anonymous reviewers and Associate Editor Professor Ali Danesh for their helpful suggestions. The authors gratefully acknowledge Professor Tareq Mahafza, Drs. Marina Mahafza and Tareq Khrais for their excellent support with research design and statistical analyses. We would also like to acknowledge Dr Christopher Wigham for his proof reading.

## References

- Andersson, G., 2002. Psychological aspects of tinnitus and the application of cognitive-behavioral therapy. *Clinical Psychology Review*, 22(7), pp.977–990.
- Axelsson, A. and Ringdahl, A., 1989. Tinnitus—a study of its prevalence and characteristics. *British Journal of Audiology*, 23(1), pp.53-62.
- Baskill, J.L. and Coles, R.R.A., 1999, September. Relationship between tinnitus loudness and severity. In *Sixth International Tinnitus Seminar* (pp. 424-428). Cambridge eUnited Kingdom: The Tinnitus and Hyperacusis Centre.
- Bhatt, J.M., Bhattacharyya, N. and Lin, H.W., 2017. Relationships between tinnitus and the prevalence of anxiety and depression. *The Laryngoscope*, 127(2), pp.466-469.
- Beukes, E.W., Manchalah, V., Andersson, G., Allen, P.M., Terlizzi, P.M., Baguley, D.M., 2018. Situationally influenced tinnitus coping strategies: a mixed methods approach. *Disability and Rehabilitation*, 40(24), 2884-2894.
- Cima, R.F., Vlaeyen, J.W., Maes, I.H., Joore, M.A. and Anteunis, L.J., 2011. Tinnitus interferes with daily life activities: a psychometric examination of the Tinnitus Disability Index. *Ear and Hearing*, 32(5), pp.623-633.
- Dauman, N., Erlandsson, S.I., Albarracín, D., Dauman, R. Exploring tinnitus-induced disablement by persistent frustration in aging individuals: a grounded theory study. *Frontiers in Aging Neuroscience*, 2017. 9:272. doi: 10.3389/fnagi.2017.00272.
- Davies, S., McKenna, L. and Hallam, R.S., 1995. Relaxation and cognitive therapy: a controlled trial in chronic tinnitus. *Psychology and Health*, 10(2), pp.129-143.
- Durai, M., and Searchfield, G.D., 2017. A Mixed-Methods Trial of Broad Band Noise and Nature Sounds for Tinnitus Therapy: Group and Individual Responses Modeled under the Adaptation Level Theory of Tinnitus. *Frontiers in Aging Neuroscience*, 9:44. doi: 10.3389/fnagi.2017.00044
- Fackrell, K., Hall, D.A., Barry, J.G. and Hoare, D.J., 2016. Psychometric properties of the Tinnitus Functional Index (TFI): Assessment in a UK research volunteer population. *Hearing Research*, 335, pp.220-235.
- Fackrell, K., Hall, D.A., Barry, J.G. and Hoare, D.J., 2018. Performance of the Tinnitus Functional Index as a diagnostic instrument in a UK clinical population. *Hearing Research*, 358, pp.74-85.
- Folmer, R.L., Griest, S.E., Meikle, M.B. and Martin, W.H., 1999. Tinnitus severity, loudness, and depression. *Otolaryngology - Head and Neck Surgery*, 121(1), pp.48-51.
- Hall, D.A., Haider, H., Szczepek, A.J., Lau, P., Rabau, S., Jones-Diette, J., Londero, A., Edvall, N.K., Cederroth, C.R., Mielczarek, M. and Fuller, T., 2016. Systematic review of outcome domains and instruments used in clinical trials of tinnitus treatments in adults. *Trials*, 17(1), p.270.
- Harrop-Griffiths, J., Katon, W., Dobie, R., Sakai, C. and Russo, J., 1987. Chronic tinnitus: association with psychiatric diagnoses. *Journal of Psychosomatic Research*, 31(5), pp.613-621.
- Hébert, S., Mazurek, B. and Szczepek, A.J., 2017. Stress-related psychological disorders and tinnitus. In: Szczepek A., Mazurek B. (eds). *Tinnitus and Stress* (pp. 37-51). Springer, Cham.
- Heller, A.J., 2003. Classification and epidemiology of tinnitus. *Otolaryngologic Clinics of North America*, 36(2), pp.239-248.

- Henry, J.A., Dennis, K.C. and Schechter, M.A., 2005. General review of tinnitus. *Journal of Speech, Language, and Hearing Research*, 48(5), pp. 1204-1235.
- Henry, J.A., Griest, S., Thielman, E., McMillan, G., Kaelin, C. and Carlson, K.F., 2016. Tinnitus Functional Index: Development, validation, outcomes research, and clinical application. *Hearing Research*, 334, pp.58-64.
- Hoare, D.J., Broomhead, E., Stockdale, D. and Kennedy, V., 2015. Equity and person-centeredness in provision of tinnitus services in UK National Health Service audiology departments. *European Journal for Person Centered Healthcare*, 3(3), pp.318-326.
- Kaldo, V., Cars, S., Rahnert, M., Larsen, H. C., & Andersson, G., 2007. Use of a self-help book with weekly therapist contact to reduce tinnitus distress: a randomized controlled trial. *Journal of Psychosomatic Research*, 63(2), pp.195–202.
- Khilnani, A.K., Thaddanee, R., Chodvadiya, M. and Khilnani, G., 2018. Correlation of severity of tinnitus with severity of anxiety and depression in adults in a tertiary care hospital at Bhuj, Gujarat, India. *International Journal of Otorhinolaryngology and Head and Neck Surgery*, 4(4), p.1044.
- Kuk, F.K., Tyler, R.S., Russell, D. and Jordan, H., 1990. The psychometric properties of a tinnitus handicap questionnaire. *Ear and Hearing*, 11(6), pp.434-445.
- Langguth, B., Landgrebe, M., Kleinjung, T., Sand, G.P. and Hajak, G., 2011. Tinnitus and depression. *The World Journal of Biological Psychiatry*, 12(7), pp.489-500.
- Malouff, J. M., Noble, W., Schutte, N. S., & Bhullar, N., 2010. The effectiveness of bibliotherapy in alleviating tinnitus-related distress. *Journal of Psychosomatic Research*, 68(3), pp.245–251.
- Marks, E., Smith, P., McKenna, L. (2019). Living with tinnitus and the health care journey: an interpretative phenomenological analysis. *British Journal of Health Psychology*, 24, pp. 250-264.
- McCombe, A., Baguley, D., Coles, R., McKenna, L., McKinney, C. and Windle-Taylor, P., 2001. Guidelines for the grading of tinnitus severity: the results of a working group commissioned by the British Association of Otolaryngologists, Head and Neck Surgeons, 1999. *Clinical Otolaryngology & Allied Sciences*, 26(5), pp.388-393.
- McKinney, C.J., Hazell, J.W.P. and Graham, R.L., 1999, September. An evaluation of the TRT method. In *Proceedings of the Sixth International Tinnitus Seminar* (pp. 99-105). Hyperacusis & Tinnitus Centre, London.
- Meikle, M.B., Henry, J.A., Griest, S.E., Stewart, B.J., Abrams, H.B., McArdle, R., Myers, P.J., Newman, C.W., Sandridge, S., Turk, D.C. and Folmer, R.L., 2012. The tinnitus functional index: development of a new clinical measure for chronic, intrusive tinnitus. *Ear and Hearing*, 33(2), pp.153-176.
- Meikle, M.B., Stewart, B.J., Griest, S.E. and Henry, J.A., 2008. Tinnitus outcomes assessment. *Trends in Amplification*, 12(3), pp.223-235.
- Meng, Z., Chen, Z., Xu, K., Li, G., Tao, Y. and Kwong, J.S.W., 2016. Psychometric properties of a Mandarin version of the tinnitus questionnaire. *International Journal of Audiology*, 55(6), pp.366-374.
- Newman, C.W., Sandridge, S.A. and Jacobson, G.P., 1998. Psychometric adequacy of the Tinnitus Handicap Inventory (THI) for evaluating treatment outcome. *Journal American Academy of Audiology*, 9, pp.153-160.
- Pilgramm, M., Rychlik, R., Lebisch, H., Siedentop, H., Goebel, G. and Kirchhoff, D., 1999. Tinnitus in der Bundesrepublik Deutschland. Eine repräsentative epidemiologische studie. *HNO aktuell*, 7(4), pp.261-265.
- Pinto, P.C.L., Sanchez, T.G. and Tomita, S., 2010. The impact of gender, age and hearing loss on tinnitus severity. *Brazilian journal of otorhinolaryngology*, 76(1), pp.18-24.

- Prabhu, P.P. and Chandan, H.S., 2014. Psychoacoustic characteristics of tinnitus in individuals with auditory neuropathy spectrum disorder. *Audiology Research*, 4(1).
- Savastano, M., 2008. Tinnitus with or without hearing loss: are its characteristics different?. *European Archives of Oto-Rhino-Laryngology*, 265(11), pp.1295-1300.
- Schecklmann, M., Pregler, M., Kreuzer, P.M., Poepl, T.B., Lehner, A., Crönlein, T., Wetter, T.C., Frank, E., Landgrebe, M. and Langguth, B., 2015. Psychophysiological associations between chronic tinnitus and sleep: a cross validation of tinnitus and insomnia questionnaires. *BioMed Research International*, 461090.
- Searchfield, G.D., Jerram, C., Wise, K. and Raymond, S., 2007. The impact of hearing loss on tinnitus severity. *Australian and New Zealand Journal of Audiology*, 29(2), pp.67-76.
- Searchfield, G.D., Kaur, M., and Martin, W.H., 2010. Hearing aids as an adjunct to counseling: Tinnitus patients who choose amplification do better than those that don't, *International Journal of Audiology*, 49(8), pp. 574-579.
- Udupi, V.A., Uppunda, A.K., Mohan, K.M., Alex, J. and Mahendra, M.H., 2013. The relationship of perceived severity of tinnitus with depression, anxiety, hearing status, age and gender in individuals with tinnitus. *International Tinnitus Journal*, 18(1).
- Wilson, P.H., Henry, J., Bowen, M. and Haralambous, G., 1991. Tinnitus reaction questionnaire: psychometric properties of a measure of distress associated with tinnitus. *Journal of Speech, Language, and Hearing Research*, 34(1), pp.197-201.
- Zhao, F., Stephens, S.D.G, Ishak W,S., Meyer-Bisch, C., 2014. The characteristics of Audioscan and DPOAE measures in tinnitus patients with normal hearing thresholds. *International Journal of Audiology* 2014, 53(5), 309-17.
- Zhao, Y.X., Zhao, F., El Refaie, A., Wang, B.C., Chen, D.P., Chen, K.S., and Lan, T.X., 2020, Long-term Effectiveness of Tinnitus Multivariate Integrated Sound Therapy (T-MIST) in Tinnitus Patients with Normal Hearing Thresholds: A Preliminary Study. *Clinical Otolaryngology (in press)*.