

An Investigation of the Impact of Tinnitus Perception on the Quality of Life

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ABSTRACT

Purpose: the aim of this study is to assess the impact of tinnitus perception on the quality of life of tinnitus sufferer's. **Materials and methods:** 34-tinnitus sufferers were recruited in this study with a wide range of hearing loss thresholds (HLT) and tinnitus severity status. Pure tone air conduction audiometry was performed to assess the hearing level of the participants in this study. Anxiety and depression were assessed in this study using the hospital anxiety and depression scale (HADS). Tinnitus severity was assessed using tinnitus handicap inventory (THI) and tinnitus functional index (TFI). **Results:** The impact of tinnitus perception on the quality of life was found higher in suffering group comparing to coping group. A significant positive correlation was found between the age of tinnitus subjects and their hearing loss thresholds. The TFI score was found significantly higher in the unilateral group compared to the bilateral group. Awareness was found the highest TFI distributed dominate, while social activity was the lowest TFI distributed dominate. A significant positive correlation was found between hearing loss and tinnitus duration. Also, the correlation between tinnitus severity and anxiety and depression was identified in this study. **Conclusion:** these findings revealed that tinnitus perception has negative impacts on the quality of life. Tinnitus laterality may seem to play a factor on the tinnitus severity.

Key words: Tinnitus, hearing loss thresholds, tinnitus handicap inventory, and tinnitus functional index.

- **Introduction**

Tinnitus is the sensation of sound in the absence of any external source. Millions of people around the world are affected by tinnitus and its origin not yet fully understood. The prevalence of tinnitus has been estimated to be between 10-15% of the adult population [1]. The majority of tinnitus sufferers have subjective tinnitus that cannot be heard by examiner, but only described by the tinnitus subject. The condition can sometimes have serious psychological impacts on the individual such as dealing with problem, depression and anxiety, low concentration and loss of control [2, 3].

One of the tinnitus challenges is that most individuals who experience tinnitus cope well whilst some do not. Various tinnitus questionnaires such as Tinnitus Handicap Inventory (THI) [4] and the Tinnitus Functional Index (TFI) [5] have been published that aim to investigate the influence of tinnitus on different impacts of tinnitus sufferer's life such as emotional, functional, claustrophobic, hearing, anxiety and depression. Due to there be no objective tool to diagnose most tinnitus cases, clinical practitioners have been using these questioners widely in order to assess the impact and severity of tinnitus.

There are some psychoacoustic characteristics used to evaluate tinnitus such as tinnitus intensity, frequencies and suppression levels). Jastroboff and Hazel found no association between tinnitus coppers and suffers of these psychoacoustic characteristics. On the other hand, other studies found the correlation between tinnitus intensity and severity [6, 7].

The influence of hearing loss on tinnitus severity has been investigated with wide divergent results. Baskil has demonstrated that the correlation between hearing loss and tinnitus severity is uncertain. On the other hand, tinnitus annoyance was linked with hearing loss at low and high frequencies [8, 9]. The prevalence of tinnitus is increased with age [10]. Tinnitus severity was found not correlated to age in one study [11], whereas another study found older male showed higher severity of tinnitus symptoms [12].

As individuals react differently to different symptoms and disorders, this study aims to assess the impact of tinnitus perception on the quality of life of tinnitus sufferer's. This will be justified by taking into account the influence of some behavior variables: age, gender, handedness, anxiety and depression status, hearing loss and tinnitus characteristics such as onset, laterality, loudness and severity.

- **Material and methods**

- **Subject**

The ethical application of this study was approved by the National Research committee in North West (Liverpool, UK). Certain inclusion and exclusion criteria were set in this study. Inclusion criteria were as following: age between 30-65 years olds, subjective tinnitus for at least 6 months, and no conductive hearing loss.

34-tinnitus sufferers were recruited in this study with a wide range of hearing loss thresholds and tinnitus severity status. Participants were recruited from announcements in the University of Liverpool's website and referral via Aintree University Hospital NHS Foundation Trust.

- **Audiological examination**

Pure tone air conduction audiometry was performed to assess the hearing level of the participants in this study. Audiograms were measured with a calibrated diagnostic audiometer (Amplivox 2160, with Audiocups to reduce noise and permit accurate pure tone audiometry). The pure tones were presented at seven different octave frequencies (0.5, 1.0, 2.0, 3.0, 4.0, 6.0, 8.0 kHz), and at different sound intensities that ranged from -10 to 120 dBHL. A consultant audiological physician performed the hearing assessment at the University of Liverpool site in a quiet office with ambient noise levels less than 35dB. Hearing function was defined as the mean hearing loss thresholds, averaged over the seven frequencies tested for each ear.

- **Behavior assessment**

Handedness was assessed in this study by using Edinburgh Handedness Inventory (EHI) [13]. In addition, anxiety and depression was screened for all participants by completing Hospital Anxiety and Depression Scale (HADS) [14].

In order to assess the effect of tinnitus on participants' lifestyle, the tinnitus group was asked to complete two tinnitus questionnaires the THI and TFI. The THI has been used in this study as it has been used widely in clinics, to assess the impact of tinnitus at three sub-scales: emotional, functional and catastrophic subscales. On the other hand, the TFI is a relatively new index, which is currently under validation and examines the impact of tinnitus at eight tinnitus dominants: awareness, coping, concentration, sleeping, hearing, relaxation, social activity and anxiety and depression.

- **Results**

- **Demographics findings:**

The characteristics of the tinnitus participants were listed in table 1. This study included 34 tinnitus patients: 20 male (59%), and 14 women (41%). The age range of tinnitus participants was from 30 to 65 years old. The mean and standard deviation age of tinnitus patients was 48 ± 11 years. The anxiety and depression scale showed that 15 tinnitus subjects (44%) have anxiety and depression (10 male), while 19 subjects (56%) do not. The handedness of tinnitus participants was 28 right handed (82%) and 6 left handed (18%).

23 tinnitus subjects (68%) are experiencing tinnitus symptoms in both ears (bilateral), while eleven tinnitus subjects (32%) have experiencing tinnitus sounds in one ear either right or left (unilateral). Furthermore, hearing loss occurred in 23 (63%) tinnitus patients, and 11 (37%) tinnitus subjects had normal hearing as measure with pure tone audiometry.

Tinnitus subjects were asked whether they could cope with their tinnitus or not. Half of the tinnitus participants showed that they could cope with their tinnitus.

The onset of tinnitus has been categorized into two groups: 5 years or less and more than 5 years. Thirteen tinnitus (38%) subjects have been experiencing tinnitus for five years or less, while twenty-one (62%) have been experiencing tinnitus for more than five years.

Tinnitus participants described tinnitus sound as whistling (35.1%), hissing (27.7%), ringing (12.9%), roaring (9.2%), pulsating (5.6%), high pitch noises (5.6%), clanging (1.85%) and chirping (1.85%).

Variables	Tinnitus population
Sample size	34
Gender	
Male	20 (59%)
Female	14 (41%)
Handedness	
Right handed	28 (82%)
Left handed	6 (18%)
Anxiety and depression	
Yes	15 (44%)
No	19 (56%)
Hearing level	
Normal hearing	11 (34%)
Hearing loss	23 (66%)
Severity	
Coping	17 (50%)
Suffering	17 (50%)
Laterality	
Unilateral	11 (32%)
Bilateral	23 (68%)
Onset	
≤ 5 years	13 (38%)
> 5 years	21 (62%)
Tinnitus descriptions	
Whistling	35.1%
Hissing	27.8%
Ringing	12.96%
Roaring	9.26%
Pulsating	5.6%
High pitch noises	5.6%
Clanging	1.85%
Chirping	1.85%

Table 1: the demographics and characteristics of tinnitus participants

○ **Audiological findings**

Clinical pure tone audiometry was performed on each subjects and the mean and standard deviation for each ear is shown in Chart1. Normal hearing was defined as pure tone hearing thresholds of 20 dB or better at these frequencies, and hearing loss was defined as a hearing threshold more than 25 dB at any frequency.

The left ear audiograms showed higher hearing loss thresholds than the right ear at 3, 4, 6 and 8 kHz, however, it did not reach significant level ($P \geq 0.05$). Furthermore, no significant different was found of the hearing loss level between gender (male and female), handedness (right and left handed), anxiety and depression subgroups (yes and no), tinnitus-severity groups (bothersomes and non-bothersomes),

tinnitus laterality (bilateral and unilateral) and tinnitus onset groups (5 years or less and more than 5 years) (table2). Tinnitus subjects with hearing loss group (50 ± 11 years old) were significantly older ($P=0.02$) than tinnitus subjects with normal hearing group (41 ± 9 years old).

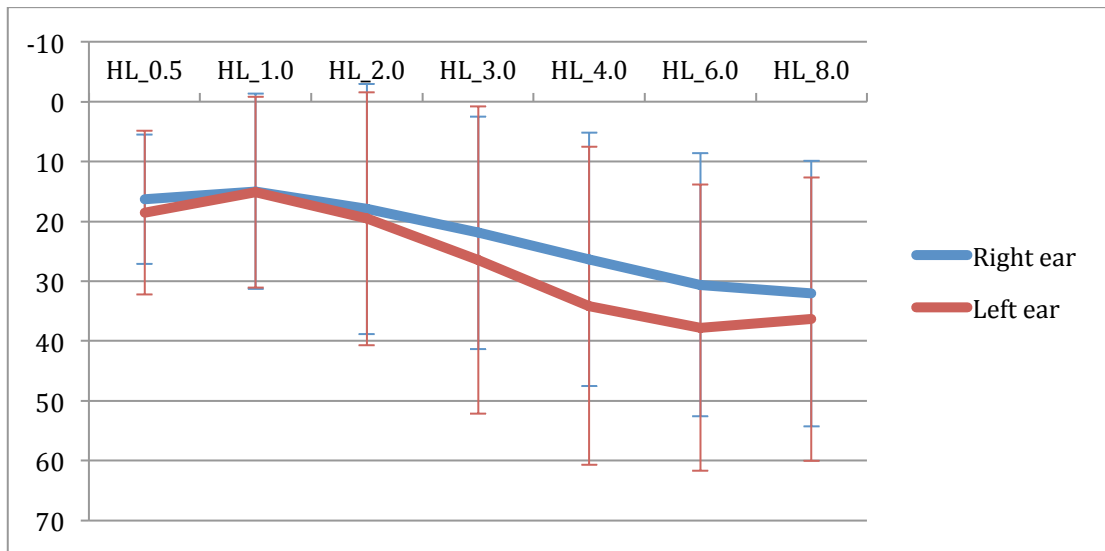


Chart 1: the mean and standard division of right and left ear audiograms

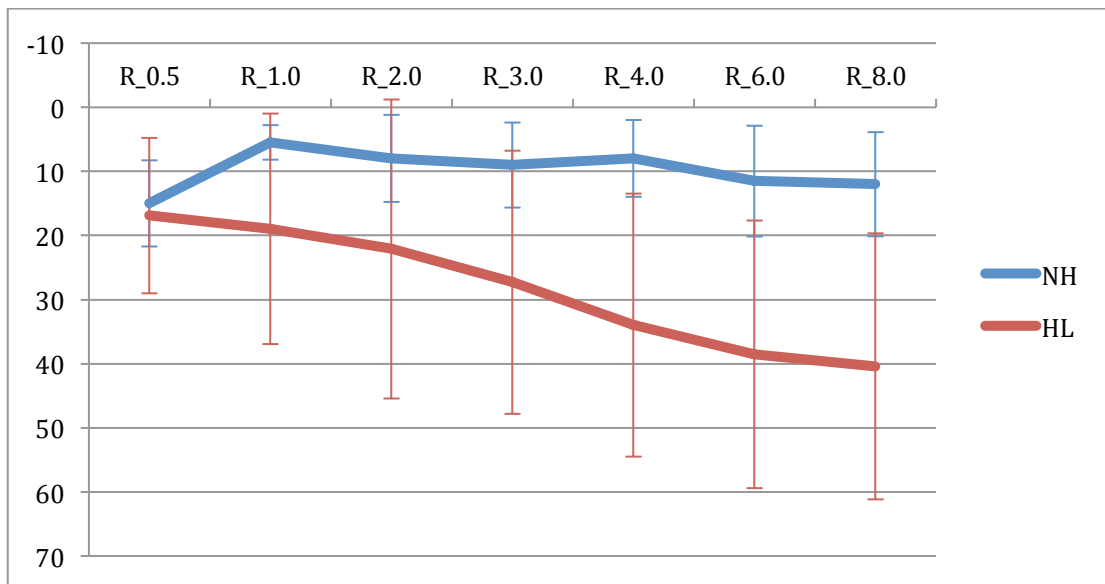


Chart 2: the mean and standard division of right ear between tinnitus subjects with normal hearing (NH) and tinnitus subjects with hearing loss (HL)

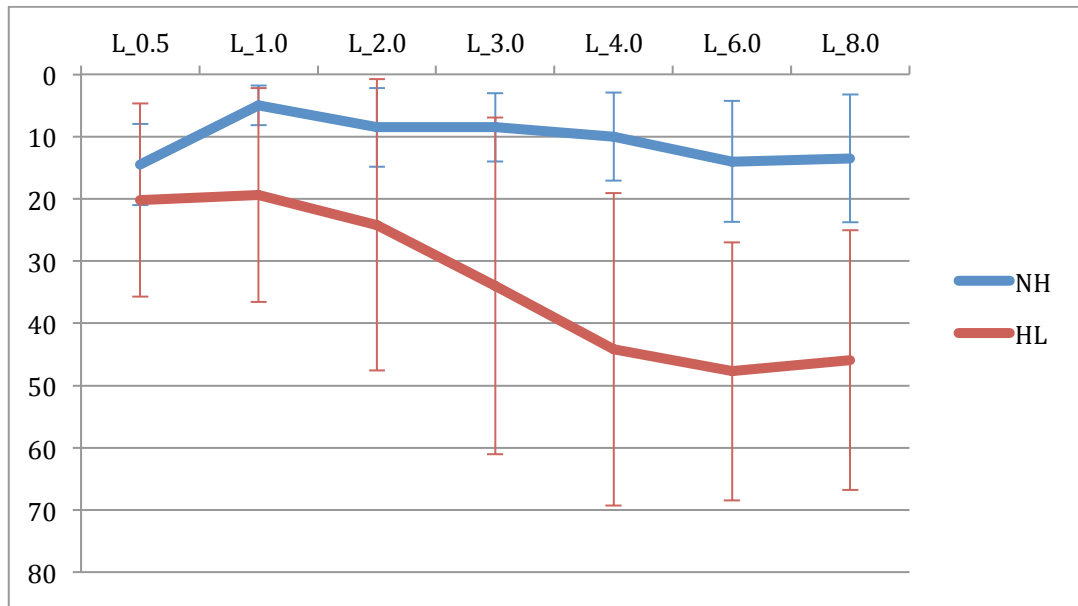


Chart 3: the mean and standard division of left ear between tinnitus subjects with normal hearing and tinnitus subjects with hearing loss

Variables	Right ear	Left ear	Average	HLT
Gender				
Male (n=20)	27±18	29±18	28±18	51±23
Female (n=14)	17±13	23±19	20±15	43±27
P-value	0.063	0.36	0.16	0.32
Handedness				
Right (n=28)	22±14	25±17	23±14	44±23
Left (n=6)	27±25	37±24	32±24	67±26
P-value	0.64	0.27	0.42	0.08
Anxiety and depression				
Yes (n=15)	18±11	23±13	20±11	45±21
No (n=19)	26±18	29±19	28±20	51±28
P-value	0.12	0.3	0.19	0.47
Hearing loss				
Yes (n=23)	29±16	34±18	31±16	61±20
No (n=11)	10±5	11±6	11±5	22±5
P-value	0.001	0.0003	0.0003	0.000005
Bothering				
Coping (n=17)	25±19	26±22	25±20	47±28
Suffer (n=17)	21±13	28±15	24±13	49±22
P-value	0.5	0.8	0.86	0.87
Laterality				
Unilateral (n=11)	24±18	25±21	25±2	45±3
Bilateral (n=23)	20±10	30±11	25±9	54±2
P-value	0.45	0.44	0.97	0.29
Onset				
≤ 5 years (n=13)	18±12	22±13	20 ± 12	40±17
> 5 years (n=21)	26±18	30±21	28±19	53±28
P-value	0.2	0.2	0.15	0.12

Table 2: T-test results of the effect of different variables (gender, handedness, hearing loss, tinnitus bothering, tinnitus laterality and tinnitus inset on hearing acuity. (Right ear: averaged hearing loss thresholds on the right ear, Light ear: averaged hearing loss thresholds on the left ear, HLT: hearing loss thresholds).

○ **Tinnitus severity findings**

The impact of tinnitus perception on the quality of life was assessed using THI and TFI. The overall results of THI and TFI are summarized in table3. In THI questionnaire, the percentages of tinnitus subjects according to the impact of tinnitus in their life are 41.2% (slight impact), 32.4% (mild impact), 17.6% (moderate impact) and 8.8% (catastrophic impact). In TFI inventory, 44.2% showed a mild impact, 23.5% of tinnitus subjects showed a slight influence and 32.4% showed a sever impact.

Tinnitus inventories	Mean scores levels	Prevalence Percentage
THI	Slight	41.2%
	Mild	32.4%
	Moderate	17.6%
	Catastrophic	8.8%
TFI	Mild	44.2%
	Moderate	23.5%
	Sever	32.4%

Table 3: The impact of tinnitus perception results using THI and TFI.

The influence of tinnitus perception on eight TFI dominates was assessed in this study (table4). Awareness was found the highest (58%) distributed TFI dominate, while social activity (20%) was the lowest distributed TFI dominate. Half of tinnitus participants showed that they could control and manage tinnitus severity. Also, sleep impairment was assessed in tinnitus participants using sleeping dominate in TFI inventory, which was found that 44% (15 out of 34) of tinnitus subjects have distributed sleep. Relaxation and enjoyment was fount to be distributed by 28% of participants. The ability of hearing was influenced by tinnitus perception in 35% of tinnitus subjects. Attention and focusing ability was found influenced in 26% of tinnitus subject. 23% of tinnitus participants thought that tinnitus could increase their anxious and depression level.

TFI dominates	TFI score (M±SD)	Distributed percentage (%)
Awareness	15.7±6.8	58%
Coping	14.5±7.1	50%
Attention	10±8.4	26%
Sleeping	10.8±9.6	41%
Hearing	11.7±8.5	35%
Relaxation	14.1±8.1	38%
Social activity	10.1±0.7	20%
Anxious and depression	7.76±8.5	23%

Table 4: The mean (M), standard division (SD) and the distributed percentage for each TFI dominate. Distributed percentage was determined as the overall score of each dominant exceed the scale.

No significant difference in the impact of tinnitus perception on the quality of life was found between gender (male and female), handedness (right and left handed), hearing loss levels (normal hearing and hearing loss) and the onset of tinnitus (5 years or less and more than 5 years). Tinnitus participants with hearing loss (50±11 years) were found significantly older ($P=0.02$) than tinnitus participants with normal hearing (41±10 years). The TFI score was found significantly higher ($P=0.007$) in the unilateral group (55±23) compared to the bilateral group (30±18) (chart4). Suffering group showed higher impact of tinnitus perception than coping group in both inventories THI and TFI (table5).

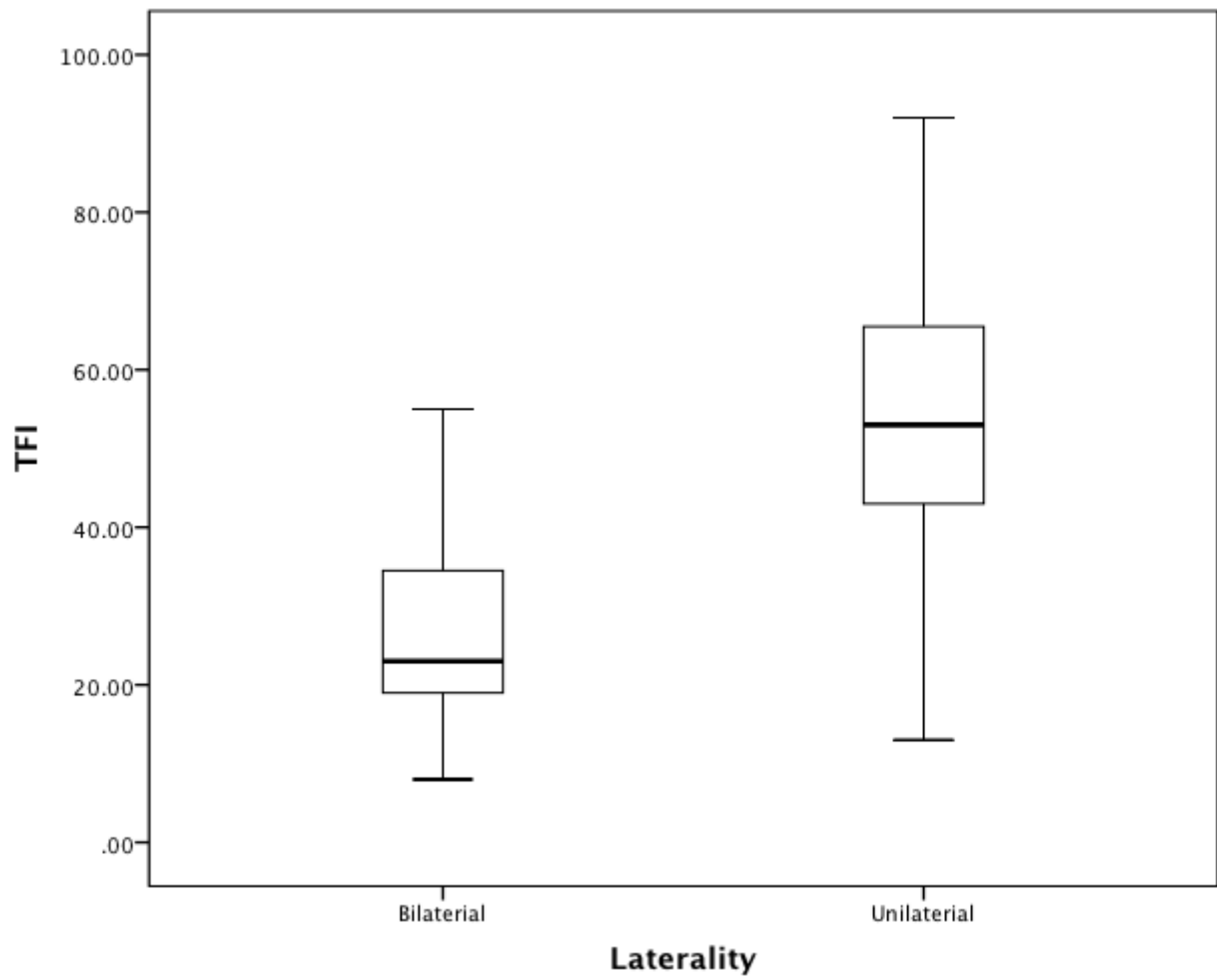


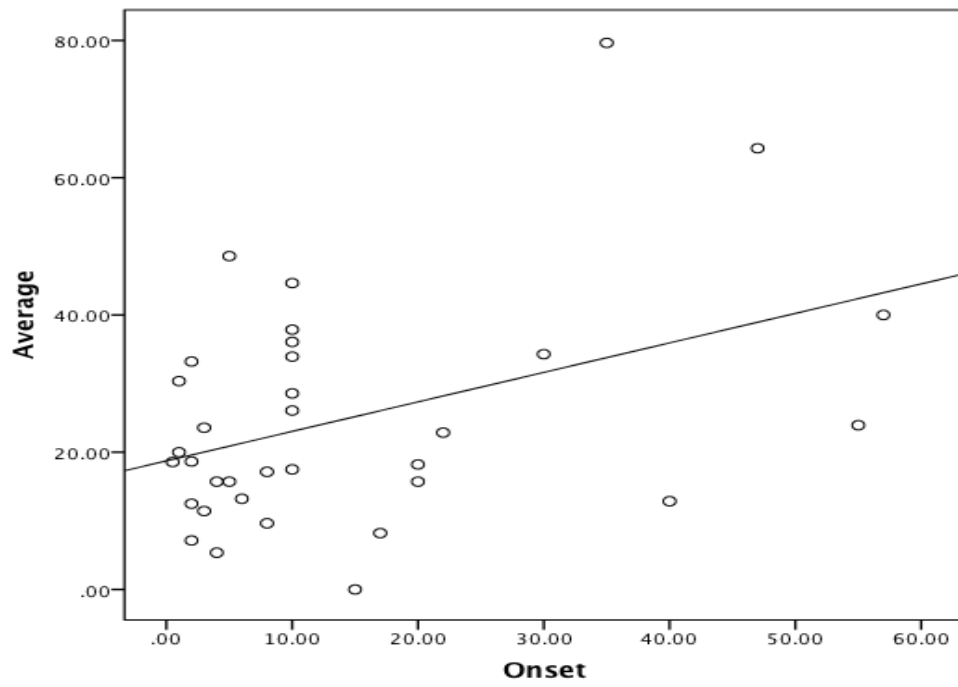
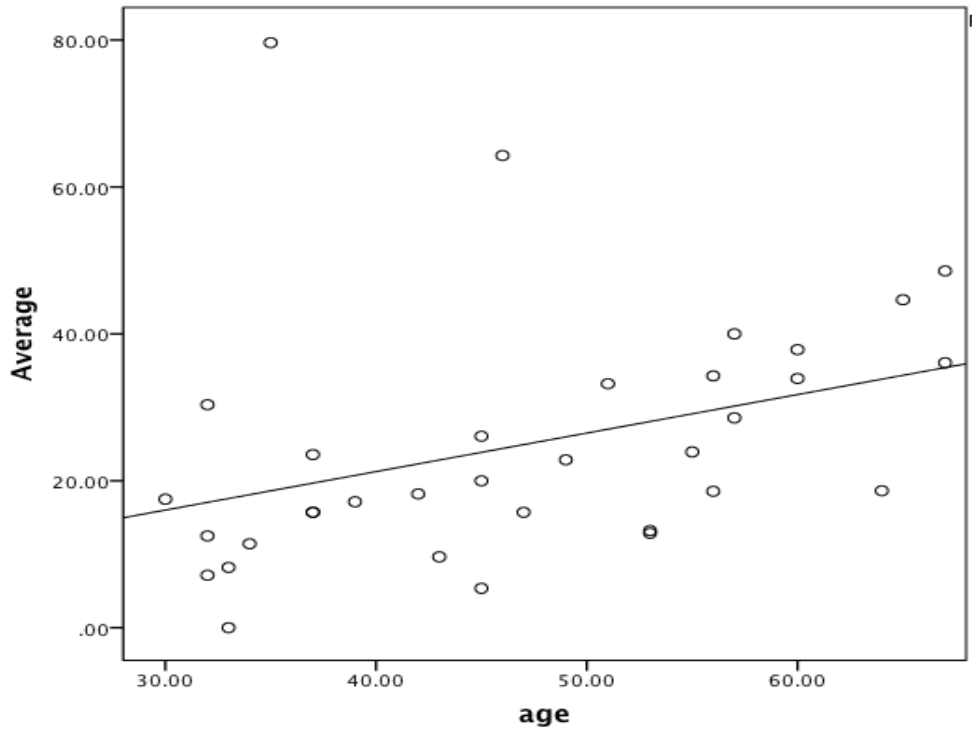
Chart 4: Boxplot charts showed the effect of tinnitus laterality on tinnitus severity.

Variables	Age (Years)	HADS (Scores)	THI (Scores)	TFI (Scores)
Gender				
Male (n=20)	48±13	11±7	29±26	38±25
Female (n=14)	46±9	9±6	31±22	38±21
P-value	0.6	0.5	0.88	0.96
Handedness				
Right (n=28)	46±11	10±7	29±23	37±23
Left (n=6)	51±12	11±3	34±31	44±24
P-value	0.37	0.5	0.71	0.5
Hearing loss				
Yes (n=23)	50±11	9±5	27±21	38±22
No (n=11)	41±10	12±9	35±29	38.3±26
P-value	0.02	0.2	0.43	0.97
Bothering				
Coping (n=17)	43±8	9±6	15±7	21±9
Suffer (n=17)	50±13	12±7	45±26	55±21
P-value	0.068	0.22	0.00009	0.000002
Laterality				
Unilateral (n=11)	51±10	11±5	41±25	55±23
Bilateral (n=23)	45±11	10±7	25±22	30±18
P-value	0.14	0.7	0.09	0.007
Onset				
≤ 5 years (n=13)	44±12	12±4	36 ± 32	42±30
> 5 years (n=21)	48±11	9±7	26±17	35±18
P-value	0.35	0.2	0.23	0.4

Table 5: T-test results of the effect of different variables (gender, handedness, hearing loss, tinnitus bothering, tinnitus laterality and tinnitus inset on tinnitus severity).

The correlation between variables (age, HADS, hearing loss average, tinnitus onset, THI and TFI) was assessed, and found the followings:

- A significant positive correlation between subjects' ages and hearing loss average ($r=0.36$, $P=0.037$).
- A significant positive correlation between hearing loss average and tinnitus onset ($r=0.40$, $P=0.019$).
- A significant positive correlation between HADS (anxiety and depression) and tinnitus severity: THI ($r=0.57$, $P=0.0003$) and TFI($r=0.48$, $P= 0.003$).



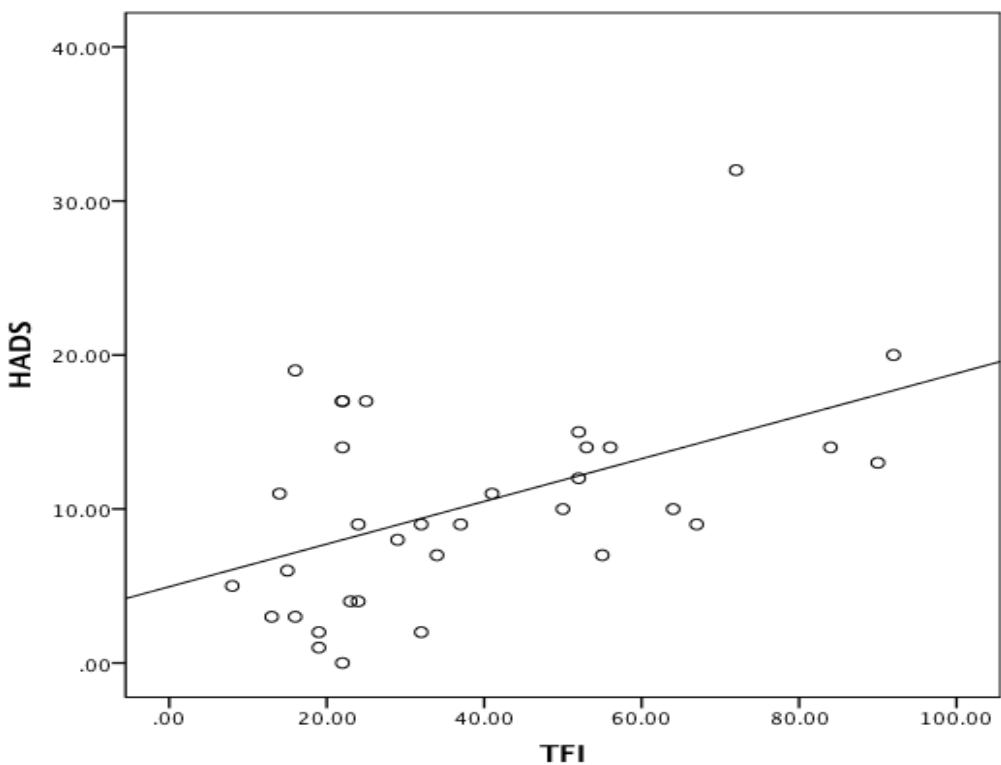
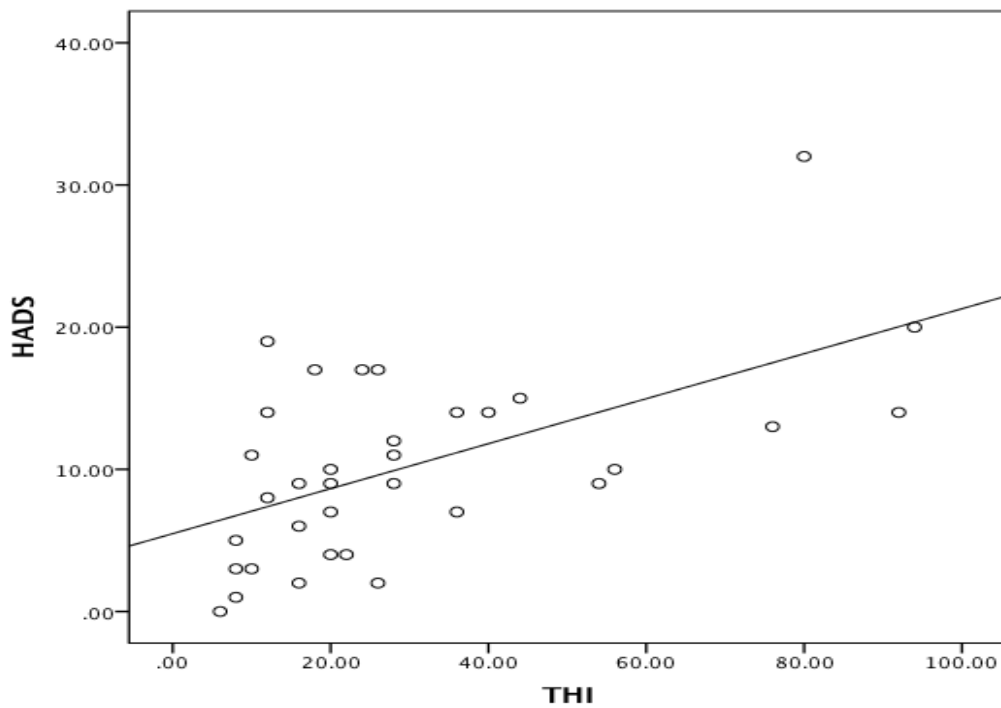


Chart 5: Positive significant correlations were identified between hearing loss average and age, hearing loss average and tinnitus onset, Hospital Anxiety and Depression Scale (HADS) and Tinnitus Handicap Inventory (THI) scores, and HADS and Tinnitus Function Index (TFI).

- **Discussion**

In this study, it was found that the prevalence of tinnitus in male (n=20) is more than in female (n=14) that is consistency with other studies [15]. Tinnitus prevalence was found lower in females compare to males under 75 years olds [16] as women are less likely to be exposed to loud exposure comparing to men who might work in loud environments.

The link between gender and tinnitus severity was seen variables as some studies found women showed higher annoyance scores comparing to male [17], while others shown the opposite [6] [18] or no correlation [3, 11]. In our study, no significant difference between males and females in terms of hearing loss and tinnitus severity was identified.

The prevalence of hearing loss and tinnitus is associated with age. However, it is unknown whether the age factor could play an important role in tinnitus severity. Some studies have found that there is no correlation between tinnitus severity and age [3, 11], however, Hiller and Goebel [12] found there is a positive correlation between tinnitus severity and age. In our study, we found that bothersome tinnitus group is older than non-bothersome tinnitus group but this different did not reach significant different (P=0.06). In correlation analysis, no significant correlation was found between participants' ages and THI or TFI. We believed that retirement could have an effect on tinnitus severity as tinnitus patients could find tinnitus is very disruptive when they spend more time in silence at home. The association between hearing impairments and retirement was identified, which found that the incidence of retirement is

significantly higher in hearing impairment population comparing to normal hearers [19, 20].

The link between tinnitus perception and hearing loss is variable [15, 21]. In our study, we found nearly two-third of the tinnitus participants had some degree of hearing loss, while one-third had normal hearing that is nearly consistent with a large epidemiology study[22].

The influence of tinnitus perception on the quality of life was assessed using two questionnaires: (THI) and (TFI). No significant differences were found in the THI and TFI scores between tinnitus participants with normal hearing and tinnitus participants with hearing loss, which has been found as well in these previous studies [3, 21, 23, 24].

We found that recent onset tinnitus can have a negative impact on the quality of life (at least initially), but the effect does not reach the significant level ($P \geq 0.05$). Participants with tinnitus duration for less than 5 years showed a higher impact of tinnitus in their life than participants with tinnitus duration for more than 5 years. It seems that tinnitus participants need more time to learn how to cope with tinnitus symptoms. Again, the affect did not reach a significant level, which may require a larger sample size that has been reported in this study [15].

Tinnitus laterality was found that it does not play a significant role on tinnitus severity (overall THI score) [15]. This study used only THI to identify the impact of tinnitus on the quality of life. We also did not find a significant difference in the THI score between unilateral and bilateral subjects. However, unilateral tinnitus participants showed a

significant higher negative impact of tinnitus (Overall TFI score) than bilateral tinnitus subjects. TFI enclose more dominants than THI, which could identify more clearly and deeply the influence of tinnitus on the quality of life.

The main limitation of this study is the small sample size and we need to conduct a larger population study that includes younger and older ages and tinnitus subjects with wide range of hearing loss. In addition, different variables should be taken into account such as medication in use, socio-demographic, occupation and education levels.

- **Conclusion**

This study demonstrated the negative impacts of tinnitus perception on the quality of life. The influence of ageing factor was found on the hearing acuity of tinnitus population. Also, tinnitus laterality seems to play a factor on the tinnitus severity. Hearing loss does not seem to have a role on tinnitus severity. Audiometry, interview and self-assessment questionnaires are considered the only assessment methods to assess the influence of tinnitus on a participants' life. Therefore, it is essential to develop an inventory that can be used to track the progress of tinnitus treatment in the future.

Conflict of interest: We declare that we have no conflict of interest.

References

1. Baguley, D., D. McFerran, and D. Hall, *Seminar: Tinnitus*. The Lancet, 2013. **382**: p. 1600-1607.
2. Holmes, S. and N.D. Padgham, *Review paper: more than ringing in the ears: a review of tinnitus and its psychosocial impact*. Journal of Clinical Nursing, 2009. **18**(21): p. 2927-2937.
3. Pinto, P.C., T.G. Sanchez, and S. Tomita, *The impact of gender, age and hearing loss on tinnitus severity*. Braz J Otorhinolaryngol, 2010. **76**(1): p. 18-24.
4. Newman, C.W., G.P. Jacobson, and J.B. Spitzer, *Development of the Tinnitus Handicap Inventory*. Arch Otolaryngol Head Neck Surg, 1996. **122**(2): p. 143-8.
5. Meikle, M.B., et al., *The tinnitus functional index: development of a new clinical measure for chronic, intrusive tinnitus*. Ear Hear, 2012. **33**(2): p. 153-76.
6. Holgers, K.M., S. Zoger, and K. Svedlund, *Predictive factors for development of severe tinnitus suffering-further characterisation*. Int J Audiol, 2005. **44**(10): p. 584-92.
7. Newman, C.W., et al., *Relationships among psychoacoustic judgments, speech understanding ability and self-perceived handicap in tinnitus subjects*. Audiology, 1994. **33**(1): p. 47-60.
8. Weisz, N., et al., *Abnormal auditory mismatch response in tinnitus sufferers with high-frequency hearing loss is associated with subjective distress level*. BMC Neuroscience, 2004. **5**(1): p. 8.
9. Searchfield, G.D., et al., *The Impact of Hearing Loss on Tinnitus Severity*. Australian & New Zealand Journal of Audiology, 2007. **29**(2): p. 67-76.
10. Coles, R.R.A., *Epidemiology of tinnitus: (1) Prevalence*. The Journal of Laryngology & Otology, 1984. **98**(SupplementS9): p. 7-15.
11. MERIC, C., et al., *Psychopathological profile of tinnitus sufferers: evidence concerning the relationship between tinnitus features and impact on life*. Audiol Neurootol, 1998. **3**(4): p. 240-52.
12. Hiller, W. and G. Goebel, *Factors influencing tinnitus loudness and annoyance*. Arch Otolaryngol Head Neck Surg, 2006. **132**(12): p. 1323-30.
13. Oldfield, R.C., *The assessment and analysis of handedness: The Edinburgh inventory*. Neuropsychologia, 1971. **9**(1): p. 97-113.
14. Zigmond, A.S. and R.P. Snaith, *The Hospital Anxiety and Depression Scale*. Acta Psychiatrica Scandinavica, 1983. **67**(6): p. 361-370.
15. Alsanosi, A.A., *Impact of tinnitus on the quality of life among Saudi patients*. Saudi Medical Journal, 2011. **32**(12): p. 1274-1278.
16. Møller, A., *Epidemiology of Tinnitus in Adults*, in *Textbook of Tinnitus*, A. Møller, et al., Editors. 2011, Springer New York. p. 29-37.
17. Davis, A.C., *2 - Hearing Disorders in the Population: First Phase Findings of the MRC National Study of Hearing*, in *Hearing Science and Hearing Disorders*, M.E. Lutman and M.P. Haggard, Editors. 1983, Academic Press: London. p. 35-60.
18. Lockwood, A., R. Salvi, and R. Burkard, *Tinnitus*. N Engl J Med, 2002. **347**: p. 904 - 910.
19. Fischer, M.E., et al., *Hearing impairment and retirement*. J Am Acad Audiol, 2014. **25**(2): p. 164-70.

20. Helvik, A.-S., S. Krokstad, and K. Tambs, *Hearing loss and risk of early retirement. The HUNT study*. The European Journal of Public Health, 2013. **23**(4): p. 617-622.
21. Savastano, M., *Tinnitus with or without hearing loss: Are its characteristics different?* European Archives of Oto-Rhino-Laryngology, 2008. **265**(11): p. 1295-1300.
22. Nondahl, D.M., et al., *Prevalence and 5-year incidence of tinnitus among older adults: the epidemiology of hearing loss study*. J Am Acad Audiol, 2002. **13**(6): p. 323-31.
23. Lim, J.J., et al., *Impact of tinnitus as measured by the Tinnitus Handicap Inventory among tinnitus sufferers in Singapore*. Singapore Med J, 2010. **51**(7): p. 551-7.
24. Hallberg, L.R. and S.I. Erlandsson, *Tinnitus characteristics in tinnitus complainers and noncomplainers*. Br J Audiol, 1993. **27**(1): p. 19-27.