



Tinnitus characteristics and associated variables on Tinnitus Handicap Inventory among a Hungarian population

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ABSTRACT

Background: Tinnitus is a sound precepted without an external sound stimulus. Its background can be categorised into primary and secondary cases. The secondary cases include pathologies of the external, middle and inner ear. Tinnitus can be objective or subjective; the latter can only identified by the sufferer. Previous research results have shown that tinnitus significantly affects the quality of life and daily functioning.

Objectives: To analyse the impact of tinnitus on the daily functioning and the possible influence of demographical data and tinnitus duration on it.

Methods: 630 patients (265 males and 365 females, 25–85 years of age) suffering from primary tinnitus were enrolled. In the Hungarian language, these patients completed the Tinnitus Handicap Inventory (THI) questionnaire and underwent a complete otorhinolaryngological examination. IBM SPSS V24 software was used for data processing; correlation tests, the Mann-Whitney *U* and Kruskal-Wallis non-parametric tests were used.

Results: According to the THI questionnaires outcomes, most patients (62.5%) were presented with a mild handicap. Based on statistical analysis, no significant correlation was observed between the total THI points and the age of the patients, along with the duration and localisation of the symptoms. However, the total THI scores of male and female patients significantly differed, indicating higher THI values in the female group ($p = 0.00052^*$).

Conclusions: The tinnitus severity was not affected by the duration, localisation of the symptoms and age but by gender, indicating higher values in the case of females.

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1. Introduction

Tinnitus affects many people worldwide and is not well appreciated by healthcare professionals. According to its definition, tinnitus is a sound precepted without an external sound stimulus [Oosterloo et al., 2021a,b]. The pathophysiological background and causes of tinnitus are not well-determined yet [Makar et al., 2014] and are categorised into primary and secondary cases. Primary tinnitus is idiopathic, which can or cannot be combined with sensorineural hearing loss. The secondary forms are associated with an identifiable organic cause. Such causes include cerumen

impaction to otosclerosis, cochlear abnormalities, and auditory nerve and central nervous system pathologies [Tunkel et al., 2014]. For instance, previous research has shown that tinnitus occurred in 69% of patients with stapedotomy, and around 70% of the cases showed an improvement after the stapedotomy was performed [Skarzynski et al., 2017a,b]. Tinnitus is referred to as objective, i. e., related to an organic reason [Cima et al., 2011] or subjective. In the case of subjective type, patients feel their ear buzz, whistle, hum, or they may hear the sound of running water. For some, tinnitus is not a vexatious complaint and does not impact daily life, whereas others might experience it as very disturbing [Chari and Limb, 2018]. According to literature, tinnitus significantly impacts the quality of life (QoL) of up to 5% of adults [Nondahl et al., 2002], with a higher frequency (7.05%) in European people [Wu et al., 2015]. Although no comprehensive survey was conducted in Hungary, it is estimated that 3–5% of the population is affected so much that

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medical assistance is sought [Szalai, 2004].

Tinnitus perception is strongly correlated with emotional impact [Searchfield et al., 2007], and self-report questionnaires often directly measure the tinnitus severity. Tinnitus Handicap Inventory Questionnaire (THI) is an example of such a questionnaires. THI is widely applied in everyday clinical practice and is a helpful questionnaire for measuring the daily life issues caused by tinnitus. The questionnaire has been validated in various languages [Skarzynski et al., 2017a,b], including the Hungarian language [Bencsik et al., 2015].

This study focuses on the impact on daily functioning of tinnitus sufferers, measured by the THI in a Hungarian population, and examines the factors associated with tinnitus severity. Factors included the patient's age, gender, symptom duration of suffering and the side of the affected ears.

2. Patients and methods

2.1. Patients

This study was embedded at the Tóth Ilona Clinical Medical Institute. The investigated group of subjects included 630 individuals between 25 and 85 years of age (265 males and 365 females). All participants have undergone a detailed examination, including case history, otolaryngological examination, pure-tone audiometry, tinnitometry, and brain MRI. The pure tone audiometry was performed using a GSI 61 Clinical Audiometer (Granson-Stadler, Inc. Milford, USA), in a soundproof booth. In the case of the pure tone-audiometry, air and bone conduction were measured, applying a headphone and a bone conduction vibrator, in 250–8000 Hz frequencies in octave steps. Masking was used in necessary cases. Before the audiometry, the middle ear status was checked by otoscopy and tympanometry (Flute inventis, ANSI S3.39-1987 type 2, Italy). Tinnitus loudness and pitch were identified using the audiometer; the patients were asked to identify which sound is the most similar to their tinnitus sound. This matching was performed three times in all participants. Age, gender, tinnitus duration and other characteristics were also collected. The patients also completed the THI questionnaire. The participants' inclusion criteria included the following: persistent primary tinnitus of a minimum of six months [Tunkel et al., 2014], patients over 18 years of age, complete documentation (including age, gender, audiometrical data, tinnitus localisation, symptom duration and THI results), and permission to participate in the investigation. Patients with an incomplete medical history were excluded and those patients who were defined to have secondary tinnitus. This study was approved by Semmelweis University Regional and Institutional Committee of Science and Research Ethics: SE RKEB – 203/2021.

2.2. Tinnitus Handicap Inventory (THI)

The questionnaire includes 25-items and can be pointed out by saying 'No = 0', 'Sometimes = 2', and 'Yes = 4' and is subdivided into three subscales: emotional (E), functional (F) and catastrophic (C). The 'E' subscale includes nine items regarding anger, anxiety, depression, frustration, irritability, and insecurity. The 'F' category is totalled by eleven questions about stress, concentration and sleeping problems, household tasks or social activeness. The remaining five items belong to the 'C' about a feeling of desperation, having a terrible disease, lack of control, and inability to escape and cope. The total THI point is defined as a summation of all three subscales points, and according to it, tinnitus severity is divided into five categories as follows: no handicap (0–16 points), 'mild' (18–36), 'moderate' (38–56), 'severe' (58–76) or 'catastrophic' tinnitus handicap (78–100 points) [Newman et al., 1996].

2.3. Statistical analysis

The IBM SPSS V24 software was applied for data processing. Since the Shapiro-Wilk test defined the not-normal distribution of the data, the Mann-Whitney *U* and Kruskal-Wallis tests were applied. A *p*-value under 0.05 was set as a significant difference in this case. Simple linear correlation, Spearman correlation, and Pearson correlation tests were used to look for correspondence of the values, and a *p*-value under 0.01 was defined as a significant correlation.

3. Results

The patients' tinnitus characteristics, including the time since the first onset of the symptoms and the involved ears side, as well as the THI score results, are presented in Table 1.

According to the THI scores seen in Table 1, only 24.9% of the patients were found in the normal range, and most patients were categorised into the mild followed by the moderate handicap category. The median duration of the symptoms was 12 months, while the median age was 65 years. Dot curves were drawn, and correlation analysis was conducted to analyse the effect of ageing on the THI results. As shown in Fig. 1., the linear correlation test ($R^2 = 0.023$) did not indicate a correlation between the total THI points and the patients' age. Pearson correlation ($\rho = 0.142$, $p = 0.01$) also highlighted this result. Spearman test suggested a non-linear correlation as well ($\rho = 0.177$, $p = 0.52$). Based on this finding, we can support the idea that a higher THI score does not directly correlate with age progression and that the complaints are overall devastating in any stage of life.

The same analyses were carried out to detect a possible correlation between the duration of the symptoms (i.e., the first onset of tinnitus). As shown in Fig. 2., the correlation between the duration of tinnitus and the questionnaire results was examined. The linear correlation analysis ($R^2 = 0.007$) indicated no correspondence between values, also confirmed by the Pearson test ($\rho = 0.086$, $p = 0.07$). Detecting a non-linear correlation by Spearman test, a non significant correlation was likewise observed ($\rho = 0.035$, $p = 0.464$). The test results implicated that in all stages of tinnitus (acute or chronic), the THI scores can be high, defining that the daily functioning of a patient is deteriorating, though not correlated with the duration and sustainability of the complaint.

The THI scores depending on the gender answers are shown in Fig. 3. Based on the boxplot, higher values regarding THI of female patients are shown, which was supported by the statistical analysis

Table 1
Tinnitus characteristics among the participants. IQR: interquartile range, Q1: first quartile, Q3: third quartile.

Tinnitus characteristics	
Male/Female (n)	265/365
Age (years) [median; IQR (Q1-Q3)]	65; 19 (52–71)
Tinnitus duration (months) [median; IQR (Q1-Q3)]	12; 43 (5–48)
<2 weeks (n)	145
>2 weeks (n)	485
Side of tinnitus (n)	
Bilateral	230
Left ear	260
Right ear	140
THI [median; IQR (Q1-Q3)]	32; 34 (18–52)
THI scores, n (%):	
No disability	157 (24.9%)
Mild handicap	225 (62.5%)
Moderate handicap	121 (19.2%)
Severe handicap	89 (14.1%)
Catastrophic handicap	38 (6%)



Fig 1. The analysis of the correlation between total THI scores and participants' age.

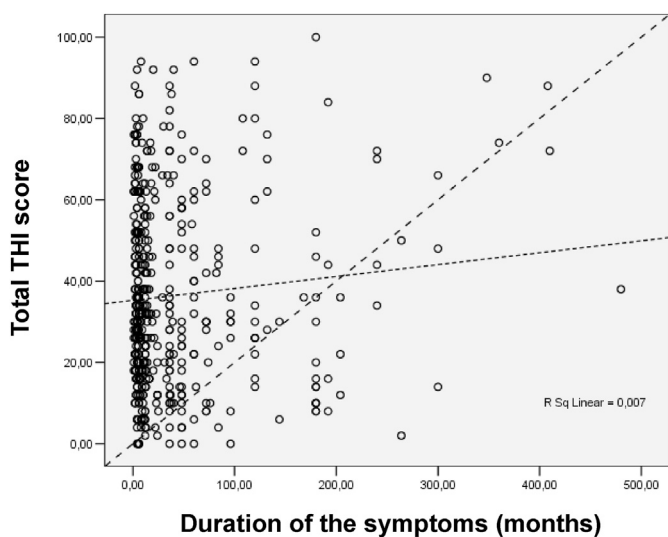


Fig 2. The analysis of the correspondence between total THI values and duration of tinnitus complaints.

($z = 3.47304$, $p=0.00052^*$, Mann-Whitney U test). It can be concluded that the female population is experiencing a worsened tinnitus handicap due to other components that influence the severity of tinnitus, such as hormonal changes or psychosocial factors, etc.

To analyse the differences between right, left, and both-sided tinnitus, the total THI scores were grouped according to the localisation of the symptoms (Fig. 4.). By analysing the side of the affected ear, no significant difference between the sides (bilateral, left, or right) was seen, also highlighted by the statistical analysis ($H = 5.8272$, $p = 0.05428$) based on the Kruskal-Wallis test.

4. Discussion

Patients suffering from tinnitus commonly report an influence on the QoL, to a varying degree. This study observed that the prevalence of tinnitus affecting the daily functioning in a general Hungarian population was high. According to the answers received, most patients reported a mild handicap, which negatively affected

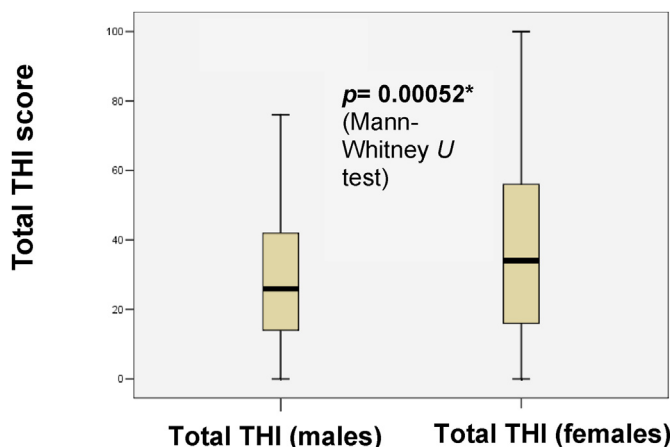


Fig 3. Comparison between total THI scores in the answers of different genders. Black line: median, box: the middle 50% of the data, whiskers: upper and lower 25%. P values were calculated using the Mann-Whitney U test. The * shows a statistically significant difference ($p < 0.05$).

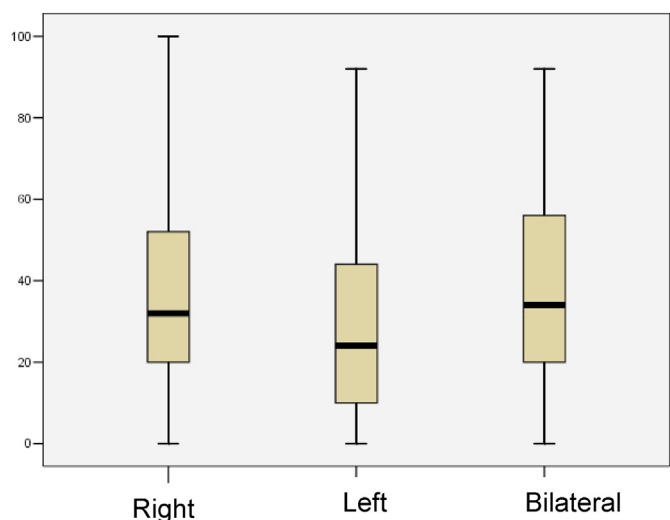


Fig 4. Comparison between total THI scores in affected sides.

their everyday living. Moreover, analysis was applied using THI questionnaires to verify which variables were independently related to tinnitus handicap.

The current investigation did not find a correspondence between the THI score and demographic variable (age), tinnitus location, or duration of complaints. Though in the sociographic variable (gender), it was found that there is a prevalence of higher THI scores in the female population. Previous research observed that among 1042 participants, no significant correlation was detected between tinnitus duration, tinnitus laterality, patients' age and global THI scores. Moreover, THI scores between tinnitus in one ear or both ear groups did also not differ. This result is analogous to the outcome of the present study. Although, a significant difference was observed between genders, referring to higher scores in terms of female sufferers. This outcome is consistent with our results. Additionally, there seemed to be a tendency in the case of hearing loss, implying higher THI scores in patients with associated hearing loss [Skarzyński et al., 2020]. Consequently, a revised grading system is necessary for subjects of different genders groups and according to the hearing status based on the results of that study. Another investigation observed that tinnitus complaint was

correlated with age, a contraindicated finding in our study population but was prominent in females according to our findings [Rhee et al., 2020]. Oosterloo et al. stated in their investigated population that tinnitus was not dependent on age and hearing loss. Therefore, these results may indicate that tinnitus potentially has a neurodevelopmental background in earlier years of life, independently of ageing [Oosterloo et al., 2021a,b]. This is a finding supported by the results of our study too.

By investigating the male and female gender odds of tinnitus, a predominance of female tinnitus sufferers was observed, which they hypothesised to be related to a higher risk of cognitive impairment seen in the female population [Fetoni et al., 2021]. Another recent study found a higher frequency of tinnitus in the case of male sufferers, while in females, there was a higher frequency of bothersome tinnitus complaints [Dawes et al., 2020]. The correlation between thyroid function and tinnitus was also examined. Their report states that a subclinical hyperthyroidism was correlated with an increased risk of annoying tinnitus, which was dominant in female patients [Kim et al., 2021]. This result can be significant as hyperthyroidism is more common in female patients; therefore, it may explain the higher tinnitus handicap in the female patient group. Another research also investigated tinnitus and hormonal changes, more precisely in menopausal women, and they concluded that hormonal treatment might improve the complaints and reduce the tinnitus handicap and tinnitus intensity [Lai et al., 2017].

A total amount of 260 patients in the present investigation reported tinnitus on the left, while 140 patients on the right-hand side and 230 had bilateral symptoms. This finding of unilateral tinnitus with a left-sided predominance has been observed in several other investigations as well [Lim et al., 2010]. Consequently, a possible link between tinnitus and hemisphere dominance was proposed, suggesting a ‘functional asymmetry’ of tinnitus [Reiss and Reiss, 2001]. A recent study using PET-CT examinations found that bilateral tinnitus was the most frequent, especially in female patients (69.2% was bilateral). A significantly increased FDG uptake in the upper temporal gyrus of male patients was observed, both in bilateral and unilateral cases, using PET-CT examinations [Shlamkovich et al., 2016]. According to their results, most of the bilateral tinnitus sufferers were male, which does not correlate with our findings.

The tinnitus questionnaires are mainly used to measure the impact of tinnitus. According to THI scores and socio- and demographic variables, it was found that there is no relationship between tinnitus and age process, as well as it is not dependent on duration or side of complaints, but it might have some association and prevalence in the female gender. This study evaluated the tinnitus characteristics and related handicaps during a single consultation; therefore, further investigation is necessary to analyse the long-term effects of tinnitus factors on the impact on the QoL and daily functioning.

5. Limitations

It should be emphasised that our study has some limitations. Firstly, only the THI questionnaire was applied to analyse tinnitus-related handicap and QoL outcomes. Other results could have been observed by incorporating other questionnaires, just like the Tinnitus Severity or the Tinnitus Handicap Questionnaires.

Ethical approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the

institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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Informed consent

Informed consent was obtained from all individual participants included in the study.

Declaration of competing interest

All of the authors declare that they have no conflict of interest.

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