

Profile Psychoacoustic of Tinnitus Patients Based on Tinnitus Handicap Inventory Evaluation

Ardelia Dillacocyta ^a, Nyilo Purnami^{b*}, Sulistiawati ^c, Hanik Badriyah Hidayati^d

^b nyilo@fk.unair.ac.id

^aMedical Program, Faculty of Medicine, Universitas Airlangga, Jalan Mayjen Prof. Dr. Moestopo no. 6-8, Airlangga, Gubeng, Surabaya 60286, Indonesia

^b Department of Otorhinolaryngology, Head and Neck Surgery, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo General Academic Hospital Center, Jalan Mayjen Prof. Dr. Moestopo no. 6-8, Airlangga, Gubeng, Surabaya 60286, Indonesia

^c Department of Public Health and Preventive Medicine, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo General Academic Hospital Center, Jalan Mayjen Prof. Dr. Moestopo no. 6-8, Airlangga, Gubeng, Surabaya 60286, Indonesia

^d Department of Neurology, Faculty of Medicine, Universitas Airlangga - Dr. Soetomo General Academic Hospital Center, Jalan Mayjen Prof. Dr. Moestopo no. 6-8, Airlangga, Gubeng, Surabaya 60286, Indonesia

Abstract

Background: The increasing incidence of tinnitus comes from exposure to noise in the workplace and daily environment, both temporary and permanent. This study was conducted to understand the psychoacoustic characteristics of tinnitus patients in the outpatient unit of the Neurotology Division of Dr. RSUD. Soetomo. **Method:** Perspective research by collecting data from medical records. **Results:** The total consisted of 47 patients from November 2022 to May 2023. The ratio of female to male patients was 1.2: 1. Most were female, 26 patients (55.3%). The largest age group was 41-50, with 17 patients (36.2%). There were 47 patients with non-pulsatile tinnitus (100%). The number of acute tinnitus patients was 32 (68.1%). Thirty-six patients (76.6%) complained of unilateral tinnitus. A total of 25 patients (53.2%) did not experience hearing loss. There were 42 patients who did not have comorbidities (89.3%). In the psychoacoustic examination, it was found that in the majority of the pitch masking data, 11 patients (23.4%) had a tinnitus frequency of 4000 Hz, loudness matching at a moderate level was 14 patients (29.8%), minimum masking levels at a severe level were 17 patients (36.1%). The hearing threshold value was moderate in 16 patients (34%). Based on the Tinnitus Handicap Inventory score, the severity was 15 patients (31.9%).

Conclusion: The majority of patients had a tinnitus frequency of 4000 Hz. Loudness matching is more at moderate degrees, minimum masking levels are at severe degrees, and hearing threshold values are mostly at moderate degrees.

Keywords: Tinnitus, Psychoacoustics, Tinnitus Handicap Inventory

1. Introduction

The World Health Organization (2023) predicts that by 2050, almost 2.5 billion people will experience hearing loss and around 700 million will need hearing rehabilitation. More than 1 billion adults will also risk permanent hearing loss (WHO, 2023). In Indonesia, it is estimated that increasing noise exposure will threaten one million workers. Even in Europe, noise-induced hearing loss is the most common occupational disease. It is feared that one in ten people in the world will experience deafness. This is because statistical data in Indonesia is quite limited and is only based on empirical experience [1].

Tinnitus comes from the Latin "tinnire," which means "to ring." People who experience tinnitus complaints report non-specific acoustic sounds such as ringing, buzzing, clicking, pulsation, and other sounds without external sources [2]. Tinnitus becomes more severe when associated with hearing loss, thereby disrupting quality of life [3]. A case study reported that increased depression and suicide attempts were related to severe tinnitus [4].

Tinnitus significantly impacts daily activities, such as hearing, communicating, working, sleeping, and mood, so it can disrupt a person's quality of life and cause psychological impacts, such as depression, anxiety, and irritability [5]. Tinnitus management consists of etiological and symptomatic therapy. However, until now, no clear etiology of tinnitus has been found [6].

Tinnitus therapy is only to relieve the symptoms of tinnitus. Therapies such as Tinnitus Retraining Therapy, Masking Therapy, Cognitive Therapy, pharmacological therapy, and so on can only improve the patient's quality of life and are not entirely effective [7]. In the form of assessing the patient's quality of life, counselling therapy can be used as an evaluation to compare the beginning and end of therapy. Questionnaire assessments can be used in counselling therapy [8]. The Tinnitus Handicap Inventory questionnaire can assess the quality of life of tinnitus patients and has been validated in daily practice [9].

2. Method

This research uses a perspective method by conducting interviews to fill out the Tinnitus Handicap Inventory questionnaire and taking audiometric examination data from medical record data in the Outpatient Unit of the Neurotology Division of Dr Soetomo General Academic Hospital Center. Inclusion criteria were patients who were diagnosed with tinnitus, had audiometric examination data, and were aged 18-60 years. The exclusion criteria were patients who were uncooperative in this study. The data collected includes information regarding age, gender, type of tinnitus, duration of complaint, location of tinnitus, hearing status, comorbidities, psychoacoustic data and degree of hearing loss based on audiometric examination, and severity of tinnitus based on the total score of the Tinnitus Handicap Inventory.

Pure tone audiometry examination is used to obtain pitch-matching, loudness-matching, and minimum masking levels data to determine the psychoacoustic characteristics of the patient's tinnitus. Assessment of quality of life in patients uses the Tinnitus Handicap Inventory questionnaire instrument, which consists of 25 questions. Of the 25 questions, there are three primary assessment items: functional reactions to tinnitus, emotional reactions, and catastrophic or dangerous reactions, with three answer choices: yes, sometimes and no. The total score of the questionnaire will be divided into five categories: no severity, mild, moderate, severe and dangerous. All information obtained will be recorded in a data collection sheet. Data will be processed descriptively and presented in table and narrative form. This research was approved by the Health Research Ethics Committee of Dr Soetomo General Academic Hospital Center Surabaya with Number 1110/LOE/301.4.2/X/2022.

3. Result

The results of this study were 47 tinnitus patients aged 18 to 60 years who visited the Outpatient Unit of the Neurotology Division of Dr. Soetomo General Hospital Academic Center. This study will describe the patient's gender, age, type of tinnitus, duration of complaint, location of tinnitus, hearing status, comorbidities, and audiometric examination results from medical record data. The score results from the Tinnitus Handicap Inventory will also be presented from patient interview data.

Table 1. Characteristics of Respondents

Variable	n	Percentage (%)
Sex		
Male	21	44.7 %
Female	26	55.3 %
Age		
18-21	2	4.3 %
21-30	10	21.3 %
31-40	9	19.1 %
41-50	17	36.2 %
51-60	9	19.1 %

Table 1 shows the distribution of sex and age; most of the patients were female, 26 patients (55.3%). The largest age group was 41-50, with 17 patients (36.2%).

Table 2. Characteristics of Tinnitus Patients

Variable	n	Percentage (%)
Type Tinnitus		
Non-Pulsatile	47	100 %
Pulsatile	0	0 %
Duration of Tinnitus		
< 6 months (Acute of Tinnitus)	32	68,1 %
< 6 month (Chronic of Tinnitus)	15	31,9 %
Location of Tinnitus		
Dextra	18	38,3 %
Sinistra	18	38,3 %
All Ear	11	23.4%
Hearing Status		
Hearing disorders	22	46,8 %
Normal	25	53,2 %
Comorbid		
No comorbid	42	89,3 %
Diabetes Mellitus + Hipertensi	1	2,1 %
Diabetes Mellitus	2	4,3 %
Hipertensi	2	4,3 %

Most of the patients were female, 26 patients (55.3%). The largest age group was 41-50 years old, with 17 patients (36.2%). There were 47 patients with non-pulsatile tinnitus (100%). The number of acute tinnitus patients was 32 (68.1%). Thirty-six patients (76.6%) complained of unilateral tinnitus. A total of 25 patients (53.2%) did not experience hearing loss. There were 42 patients who did not have comorbidities (89.3%).

Table 3. Pitch masking inspection results

<i>Pitch Masking</i>		
frequency	n	Percentage (%)
250 Hz	9	19,1 %
500 Hz	6	12.8 %
1000 Hz	5	10.6 %
2000 Hz	7	15%
4000 Hz	11	23.4 %
6000 Hz	8	17 %
8000 Hz	1	2.1 %

Based on table 3. Psychoacoustic data in the form of pitch masking mostly at a frequency of 4000 Hz for 11 patients (23.4%).

Table 4. Loudness Matching Results, Minimum Masking Level, and Hearing Threshold Values

Degree Type	<i>Loudness Matching</i>	<i>Minimum Masking Levels</i>	Hearing Threshold Value
		n (%)	
Normal (≤ 25 dB)	4 (8,5%)	1 (2,1%)	15 (31,9%)
Mild (26-40 dB)	12 (25,5%)	8 (17%)	7 (14,9%)
Moderate (41-60 dB)	14 (29,8%)	7 (14,9%)	16 (34%)
Severe (61-80 dB)	12 (25,5%)	17 (36,1%)	6 (12,8%)
Profound (≥ 81 dB)	5 (10,6%)	14 (29,8%)	3 (6,4%)
Total		47 (100%)	

Based on table 4. Most of the loudness matching was at a moderate level in 14 patients (29.8%), minimum masking levels were mostly at a severe level in 17 patients (36.1%), and hearing threshold values were mostly at a moderate level in 16 patients (34%).

Table 5. Evaluation with Tinnitus Handicap Inventory

Degree of Severity	N (%)
No (0-16)	4 (8,5%)
Mild (18-36)	11 (23,4%)
Moderate (38-56)	13 (27,7%)
Severe (58-76)	15 (31,9%)
Catastrophic handicap (78-100)	4 (8,5%)
Total	47 (100%)

Based on table 5. It was found that based on the assessment of the total score of the Tinnitus Handicap Inventory, the majority had a severe degree of severity in 15 patients (31.9%), a moderate degree in 13 patients (27.7%), a mild degree in 11 patients (23, 4%), and the non-severe degree and dangerous degree were four patients each (8.5%).

4. Discussion

This study's ratio between female and male patients was 1.2: 1. Similar results were also found in research by Oiticica et al. (2015), which indicated that the number of female patients (53%) was higher than male patients (47%), with a ratio of 1.1:1 [10]. Women tend to show worse emotional reactions to the tinnitus symptoms they experience compared to men. Therefore, in the context of tinnitus incidence, women have a lower quality of life [11].

The age group is divided into five groups, and it can be seen that the 41-50-year-old age group has the largest age group, namely 17 people (36.2%), who are included in the late adult category. This reflects that the general prevalence of tinnitus worldwide ranges from 10-25% in the adult population and increases with age [12]. Most tinnitus based on age factors can be related to exposure to noise in the work environment and daily life [13].

Tinnitus is divided into two types, namely non-pulsatile tinnitus and pulsatile tinnitus. Pulsatile tinnitus is felt as repetitive, discrete sounds synchronous with the patient's pulse. Continuous (or non-pulsatile) tinnitus, referring to all other rhythms, is usually a constant sound that does not stop [14]. The research found that all patients, namely 47 (100%), had non-pulsatile tinnitus. This research is similar to the research of Nugroho et al. (2015), with research data that all patients (100%) had non-pulsatile tinnitus.

The ratio between acute and chronic patients was 2.1:1, with 32 patients with acute tinnitus (68.1%) and 15 patients with chronic tinnitus (31.9%). Based on research by Vielsmeier et al. (2020), patients with acute tinnitus often report that their hearing has improved, but complaints of tinnitus persist. The comparison of unilateral tinnitus complaints with bilateral tinnitus was 3.27: 1, with the number of unilateral tinnitus being 36 patients (76.6%) and bilateral tinnitus being 11 patients (23.4%), which is similar to the results of the study by Nugroho et al., (2015).), with the number of unilateral tinnitus patients being 25 (80.6%) more than bilateral tinnitus [15].

Tinnitus does not cause hearing loss, but tinnitus and hearing loss often occur together. Many people who complain of tinnitus are also unaware that they have hearing loss. Tinnitus and hearing loss generally result from noise exposure [16]. The data showed that 25 patients (53.2%) had no complaints of hearing loss. Research by Nugroho et al. (2015) also found that the majority of patients did not experience hearing loss, 18 patients (58.1%).

Based on the history of comorbidities, the majority of tinnitus patients did not have comorbidities, with a total of 42 people (89.3%). Research by Purnami and Thriesnarsandhi (2020) also found that most tinnitus patients had no history of comorbidities, with a total of 134 patients (32%). This implies that the aetiology of tinnitus is caused by many factors, including exposure to noise in the surrounding environment [17].

Psychoacoustics was assessed as a comprehensive assessment of tinnitus characteristics, otoscopic examination, and pure tone audiometry. Psychoacoustics generally consists of pitch masking, loudness matching, minimum masking levels, and residual inhibition to evaluate a person's tinnitus. Pitch masking is generally a determination of the frequency characteristics of the tinnitus and its intensity to match the strength of the tinnitus. Minimum masking levels are used as the lowest level of tinnitus that can be stimulated, often in the form of narrowband noise, wideband noise, or pure tones [18].

Psychoacoustic data in the form of pitch masking was mostly at a frequency of 4000 Hz for 11 patients (23.4%). According to the classification of hearing degree criteria, most of the loudness matching was at a moderate level, with as many as 14 patients (29.8%), and minimum masking levels were mostly at a

severe level, with as many as 17 patients (36.1%), and hearing threshold values were mostly at a moderate level, as many as 16 patients (34%). Pure tone hearing threshold value data was taken from the side of the ear with the most severe tinnitus complaints. Patients with the severe type can listen to and repeat words with a normal voice spoken at a distance of 1 meter (WHO, 2001). Fauziati's (2019) research had similar results in that the largest category for hearing threshold values was a moderate degree of hearing loss.

Evaluations using the Tinnitus Handicap Inventory were mostly included in the severe category, namely 15 people (31.9%). The British Association of Otolaryngologists, Head and Neck Surgeons defines that tinnitus will be continuously felt in the severe category and difficult to disappear in the presence of environmental sounds. Sleep cycles and activities in daily life will also be disrupted. Patients with severe tinnitus often require medical consultation regarding their complaints [19].

The factors that trigger tinnitus symptoms are still not fully understood because they include multiple underlying factors. Tinnitus can also be associated with emotional and stress factors [2]. Tinnitus is associated with depression, although it is still unknown whether tinnitus is a manifestation of depressive illness or a contributing factor over a long period [20]. The use of the Tinnitus Handicap Inventory questionnaire instrument is very appropriate for assessing the quality of life of tinnitus patients. This questionnaire has also been used in medical practice and has been tested for validity. Therefore, apart from providing sound therapy and pharmacological therapy, the Tinnitus Handicap Inventory can be used as an evaluator to assess how severe the tinnitus symptoms are and can be used as a post-therapy evaluation [21].

5. Conclusion

Evaluations using the Tinnitus Handicap Inventory mainly were included in the severe category, namely 15 people (31.9%). The British Association of Otolaryngologists, Head and Neck Surgeons defines that tinnitus will be continuously felt in the severe category and difficult to disappear in the presence of environmental sounds. Sleep cycles and activities in daily life will also be disrupted. Patients with severe tinnitus often require medical consultation regarding their complaints.

The factors that trigger tinnitus symptoms are still not fully understood because they include multiple underlying factors. Tinnitus can also be associated with emotional and stress factors. Tinnitus is associated with depression, although it is still unknown whether tinnitus is a manifestation of depressive illness or a contributing element over a long period. The use of the Tinnitus Handicap Inventory questionnaire instrument is very appropriate for assessing the quality of life of tinnitus patients. This questionnaire has also been used in medical practice and has been tested for validity. Therefore, apart from providing sound therapy and pharmacological therapy, the Tinnitus Handicap Inventory can be used as an evaluator to assess how severe the tinnitus symptoms are and can be used as a post-therapy evaluation.

Acknowledgements

The author would like to thank Airlangga University and all Dr. Soetomo General Academic Hospital Center, Surabaya staff, for their assistance during data collection.

References

- [1]. Budiawan, T., Anwar, S., & Abdullah, A. (2022). Hubungan Kebisingan Dan Masa Kerja Terhadap Penyakit Tinnitus Pekerja Kilang Padi Bina Bersama Kabupaten Aceh Selatan. In *Prosiding Seminar*

Nasional" Sport Health Seminar With Real Action" Ilmu Kesehatan Masyarakat Universitas Negeri Malang.

- [2]. Langguth, B., Kreuzer, P. M., Kleinjung, T., & De Ridder, D. (2013). Tinnitus: causes and clinical management. *The Lancet. Neurology*, 12(9), 920–930.
- [3]. Lugo, A., Trpchevska, N., Liu, X., Biswas, R., Magnusson, C., Gallus, S., & Cederroth, C. R. (2019). Sex-Specific Association of Tinnitus With Suicide Attempts. *JAMA otolaryngology-- head & neck surgery*, 145(7), 685–687.
- [4]. Seo, J. H., Kang, J. M., Hwang, S. H., Han, K. D., & Joo, Y. H. (2016). Relationship between tinnitus and suicidal behaviour in Korean men and women: a cross-sectional study. *Clinical otolaryngology : official journal of ENT-UK ; official journal of Netherlands Society for Oto-Rhino-Laryngology & Cervico-Facial Surgery*, 41(3), 222–227.
- [5]. Goebel, G., Kahl, M., Arnold, W., & Fichter, M. (2006). 15-year prospective follow-up study of behavioral therapy in a large sample of inpatients with chronic tinnitus. *Acta oto-laryngologica. Supplementum*, (556), 70–79.
- [6]. Yu, S., Yu, H., Wang, X., & Du, B. (2021). The efficacy of acoustic therapy versus oral medication for chronic tinnitus: A meta-analysis. *American journal of otolaryngology*, 42(6), 103116.
- [7]. Alonso-Valerdi, L. M., Ibarra-Zárate, D. I., Torres-Torres, A. S., Zolezzi, D. M., Naal-Ruiz, N. E., & Argüello-García, J. (2023). Comparative analysis of acoustic therapies for tinnitus treatment based on auditory event-related potentials. *Frontiers in neuroscience*, 17, 1059096.
- [8]. Ukaegbe, O.C., Orji, F.T., Ezeanolue, B.C., Akpeh, J.O. and Okorafor, I.A., 2017. Tinnitus and its effect on the quality of life of sufferers: a Nigerian cohort study. *Otolaryngology–Head and Neck Surgery*, 157(4), pp.690-695.
- [9]. Nugroho, D. A., Muyassaroh, M., & Naftali, Z. (2015). Hubungan frekuensi dan intensitas tinitus subjektif dengan kualitas hidup pasien. *Oto Rhino Laryngologica Indonesiana (ORLI)*, 45(1), 19-26.
- [10]. Oiticica, J., & Bittar, R. S. M. (2015). Tinnitus prevalence in the city of São Paulo. *Brazilian journal of otorhinolaryngology*, 81, 167-176.
- [11]. Henry, J. A., Dennis, K.C., Schechter, M. A. (2005). General Review of Tinitus: Prevalence, Mechanism, Effect, and Management“, *Journal of Speech, Language, Hearing Research*; 48, pp. 1204-1235
- [12]. Bauer, C.A., 2018. Tinnitus. *N. Engl. J. Med.* 378, 1234–1231.
- [13]. Stansfeld, S., Clark, C., 2015. Health Effects of Noise Exposure in Children. *Curr. Environ. Heal. reports* 2, 171–178.
- [14]. Bathla, G., Hegde, A., Nagpal, P., & Agarwal, A. (2020). Imaging in Pulsatile Tinnitus: Case Based Review. *Journal of clinical imaging science*, 10, 84.
- [15]. Vielsmeier, V., Santiago Stiel, R., Kwok, P., Langguth, B., & Schecklmann, M. (2020). From acute to chronic tinnitus: pilot data on predictors and progression. *Frontiers in Neurology*, 11, 997.
- [16]. Tan, C. M., Lecluyse, W., McFerran, D., & Meddis, R. (2013). Tinnitus and patterns of hearing loss. *Journal of the Association for Research in Otolaryngology : JARO*, 14(2), 275–282.
- [17]. Purnami, N., & Thriesnarsandhi, Y. (2020). Tinnitus Profile in Dr. Soetomo Hospital, Surabaya. *Indian Journal of Public Health Research & Development*, 11(7), 1407-1411.
- [18]. National Guideline Centre (UK). (2020). *Evidence review for psychoacoustic measures: Tinnitus: assessment and management*. National Institute for Health and Care Excellence (NICE).
- [19]. McCombe, A., Baguley, D., Coles, R., McKenna, L., McKinney, C., Windle-Taylor, P., & British Association of Otolaryngologists, Head and Neck Surgeons (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 and allied sciences*, 26(5), 388–393.
- [20]. Savage, J., Waddell, A., 2014. Tinnitus. *Clin. Evid.* (Online). 10, 1–32

- [21]. Fernández, M., Cuesta, M., Sanz, R., & Cobo, P. (2022). Comparison of Tinnitus Handicap Inventory and Tinnitus Functional Index as Treatment Outcomes. *Audiology research*, 13(1), 23–31.