

## TINNITUS PATIENTS: ETIOLOGIC, AUDIOLOGIC AND PSYCHOLOGICAL PROFILE

PIETRO SALVAGO<sup>1</sup>, ANTONELLA BALLACCHINO<sup>2</sup>, MONICA AGRIFOGLIO<sup>2</sup>, SERGIO FERRARA<sup>1</sup>, MARIANNA MUCIA<sup>2</sup>, FEDERICO SIRECT<sup>1</sup><sup>1</sup>University of Palermo, BioNeC Department, ENT Section, <sup>2</sup>University of Palermo, Di.Bi.Me.F., Audiology Section*[Pazienti con tinnitus: profilo eziologico, audiologico e psicologico]***ABSTRACT**

Tinnitus represents one of the most frequent symptoms observed in the general population in association with different pathologies, although often its etiology remains unclear. Objective of this work is to evidence the main aspects concerning epidemiology, causes, audiological characteristics and psychological consequences of tinnitus.

**Key words:** Tinnitus, Sensorineural hearing loss, anxiety.

*Received September 11, 2012; Accepted September 17, 2012*

**Introduction**

Involving an high percentage (ranging from 10 to 25%) of the general population, tinnitus is a common symptom associated to different pathologies and defined as “perception of a sound which results exclusively from activity within the nervous system without any corresponding mechanical, vibratory activity within the cochlea”<sup>(1)</sup>.

According to literature data, about one third of the population suffers from tinnitus at least once in their life, developing in about 1-5% serious psychological and social consequences; in Italy an epidemiologic study based on questions to general population upon auditory dysfunctions evidenced a tinnitus prevalence percentage in 14.5% (8% in normal hearing subjects, 30.5% in presence of auditory dysfunctions)<sup>(2,3)</sup> while others authors reported lower prevalence percentages in different countries as Canada (1.82%) and Germany (5.2%)<sup>(4,5)</sup>.

The persistence of tinnitus could make serious disturbance and handicap at psychological and

socio-professional levels; in fact in 1-3% of the general population, the tinnitus compromises the quality of life, causing sleep disturbance, work impairment, and psychiatric distress<sup>(6,7)</sup>.

Different studies evidenced a raise in tinnitus' prevalence in older people (12% after the age of 60; 5% in the 20-30 age subjects). Probably this increase is not correlated with senescence but with the frequent coexistence of hearing loss. Tinnitus' incidence in fact increases to 70-85% among hearing-impaired patients<sup>(8,9,10)</sup>.

It is possible, using a duration criteria, to classify tinnitus in acute ( $\leq 3$  months), subacute (3-12 months) and chronic ( $> 12$  months) and to differentiate it in objective tinnitus (which can be heard by both the patient and the examiner) and subjective tinnitus (heard only by the patient). Specifically, objective tinnitus is not attributed to dysfunction of auditory nerve; it can result from the mechanical sound of muscle contractions, changes in the surface tension of mucus in the Eustachian tube, noise in the vascular system and other causes.

Subjective tinnitus, more common than the objective one, presents instead a more complex pathophysiological mechanism of onset. In fact it can be generated from multiple sites of the auditory pathway, from periphery to auditory cortex.

In most cases, despite appropriate medical examination, the origin of tinnitus remains unknown but it is well reported in literature that tinnitus and hearing impairment are often associated; either sensorineural hearing loss (SNHL) as well as acoustic trauma are considered the main causes of tinnitus. Tinnitus can be associated to other inner ear dysfunctions like sudden hearing loss<sup>(11)</sup> and it can be also a part of otological and neurological diseases such as Meniere's disease<sup>(12,13)</sup>, conductive hearing loss<sup>(14,15)</sup>, acoustic neuroma or severe head injury.

Other etiological factors have emerged from the widest epidemiological studies of tinnitus prevalence and actually they were considered as potential causes of tinnitus and/or cofactors. As reported by Hoffman these factors include frequent conditions such as vascular disease, diabetes, hypertension, autoimmune disorders and degenerative neural disorders<sup>(16,17,18)</sup>.

The high heterogeneity and complexity of etiological factors, mechanisms of onset, clinical presentation and psychological aspect of tinnitus jointed with the lack in knowledge of this pathology makes difficult the therapy approach to tinnitus by the ENT specialist.

The aim of this paper is to show an overview about epidemiology, clinical, audiological and psychological characteristics of tinnitus supported by our tertiary care center's experience.

### Gender and age

Literature data is unclear about the role of gender as risk factor in the development of tinnitus. Different studies evidenced a little increase<sup>(19,20)</sup> in tinnitus prevalence among male subjects compared to female patients but without any statistically significant difference. This fact could be justified considering the higher prevalence of chronic noise exposure (due to industrial works) among male patients.

Concerning the correlation between tinnitus and age, it is more probable to observe tinnitus in older people than in young subjects. Martines et al found an heterogeneous distribution of age among tinnitus population, evidencing a 65.7% of people with more than fifty years of age among tinnitus

patients<sup>(21)</sup>. This increase of tinnitus incidence among older people is explainable considering some aspects of elderly patients: the high prevalence of SNHL in this group, the presence of pathologies (like vascular disease, middle-ear disease, diabetes, hypertension, autoimmune disorders and degenerative neural disorders) accompanied by an increasing use of medications and finally changes in life (retirement, loss of function, loss of spouse or friends, or reduced social activity) that may bring on changes in mood, depression and anxiety.

All conditions previously exposed, potential factors of tinnitus' onset, perceived loudness and exacerbation are less frequent among young people and justify the lower tinnitus' prevalence among them.

### Etiology

As reported by different studies, an high percentage of cases of tinnitus presents an unclear etiologic factor. Savastano reported that in 26% of patients analyzed he wasn't able to correlate tinnitus with a known etiology or anatomical site<sup>(22)</sup>. Similar percentage (30.77%) was found by Martines et al, who suggested that this difficulty in etiological identification is related to the presence of coexisting psychological disorders<sup>(23)</sup>.

Concerning the main etiologic factor associated to tinnitus, the first in term of frequency is acoustic trauma (especially chronic noise exposure). Nevertheless the presence of protection mechanism used by our ears to prevent cochlear damages by noise, the exposition to intense prolonged sounds could make injuries to cochlear hair cells with possible consequent hearing loss and tinnitus. However, also after an acute acoustic trauma tinnitus is reported in the initial stages in 90% of the cases, and often persists even when the hearing loss is temporary<sup>(24)</sup>.

A second important association is between tinnitus and presbycusis, a SNHL common in elderly patients that results from the senescence of different components of the organ of Corti and the auditory pathway (atrophy of hair cells, degeneration of nerve fibers in the cochlear ganglion and the cochlear nuclei, impaired blood supply of the spiral ligament and the vascular stripe, atrophy of the spiral ligament and rupture of the cochlear duct)<sup>(25)</sup>.

Tinnitus is also associated with otosclerosis, an abnormal growth of bone of the middle ear. Gristwood in his study found in 65% of his patients

with otosclerosis the presence of tinnitus<sup>(26)</sup> but, as suggested by Deggouj, tinnitus is generated more probable by middle ear dysfunction than inner ear<sup>(27)</sup>.

Martines et al, investigating the distribution of etiologic factors in a tinnitus population evidenced the presence of Meniere's disease in 5.44% of subjects<sup>(28)</sup>. Tinnitus could be the presentation symptom of Meniere's disease or appear in association with vertigo and fluctuating hearing loss. It is most commonly of low-frequency type and it can be localized to the diseased ear or sometimes sensed in the whole head<sup>(29)</sup>.

Temporomandibular joint disorder (TMD), a group of pathologies caused by bruxism, trauma and inflammation of the temporomandibular joint, could be one of the causes of tinnitus as evidenced by different studies. It may determine the perception of tinnitus (as cracking, roaring or clicking sounds) in either one or both ears in association with mandibular movements<sup>(30,31)</sup>.

Many drugs have been linked to tinnitus. Although almost any medication can be a possible cause of tinnitus the most frequently implicated drugs are the antiinflammatories, antibiotics, and antidepressants. The first association is with the administration of aspirin and quinine. These drugs could determine a tinnitus that results high in frequency, tonal in nature, accompanied by a temporary threshold shift and reversible with cessation of the medication. Also Aminoglycoside antibiotics, loop diuretics and chemotherapeutic agents (such as cisplatin and vincristine) can be implicated in the tinnitus onset.

Finally antidepressants (i.e. amitriptyline, imipramine) can cause tinnitus<sup>(32)</sup>. Other risk factors studied are smoking, hypertension, diabetes mellitus and dyslipidemia<sup>(24)</sup>.

### **Audiological characteristics of tinnitus**

Many report evidenced high percentages of tinnitus among hearing impaired patients suggesting an association between tinnitus and hearing loss. The great variability of tinnitus prevalence in these subjects is explainable analyzing the characteristics (age, noise exposure, ears pathologies...) of subjects included in these studies<sup>(8,9,10,21,23,28)</sup>.

Furthermore, all reports cited above revealed that SNHL was mainly associated with tinnitus than conductive hearing loss, supporting the theory according to which the loss of cochlear hair cells and the consequent less effective functioning of the

cochlea efferent system represents the commonest cause of tinnitus.

Martines et al reported, in a study conducted on 312 tinnitus sufferers, a SNHL limited to the high frequencies in 58.50% of cases and of light-moderate degree in 51.28% of patients<sup>(28)</sup>, confirming data referred by Savastano, Satar, Henry and Nicolas-Puel<sup>(22,33,34,35)</sup>.

It is accepted that there is a statistically significant association between high-pitched tinnitus and high-frequency SNHL; when subjects match their tinnitus pitch to a pure tone, most of the matches are at frequencies at which hearing is impaired.

Specifically, Martines evidenced a tinnitus as a pure tone in 66.99% and matched to high frequencies in 55.13%; moreover the 72.10% of the patients with SNHL presented a high-pitched tinnitus while the 88.37% of the patients with high frequency SNHL had a high-pitched tinnitus supporting data literature of a strong relationship, statistically significant, between the type of SNHL and the tinnitus-pitch ( $P < 0.001$ )<sup>(28)</sup>.

More frequently, the subjective judgment of loudness matches for tinnitus was 10 dB above the hearing threshold (37.8%); this value suggests that most patients seek for specialist examination when the symptom is already disturbing<sup>(6,7)</sup>.

### **Psychological aspects**

Factors such as personality, psychosocial factors, and environment influence the patient's tinnitus reaction, determining different ways to experience tinnitus<sup>(18,36)</sup>. Some patients report that tinnitus doesn't compromise their quality of life, whereas others are severely affected by difficulty with concentration, sleep disturbances, anxiety, depression, or despair<sup>(18,37)</sup>; Hallam et al in their study observed<sup>(38)</sup> that the majority of patients with tinnitus generally develop a tolerance to the symptom and accept tinnitus as part of their environment within a year<sup>(39)</sup>. Furthermore, they hypothesized that an adaptation effect could determine a reduction of the problem over time and, on the basis of these, and a number of other observations, these authors proposed an habituation model of tolerance for tinnitus<sup>(38)</sup> that was designed to explain this apparent adaptation effect. We underline that they postulated that habituation to tinnitus is the normal state, whereas the inability to habituate occurs far less frequently and is due primarily to certain psychological factors.

A large number of studies investigated the relationship between tinnitus and psychopathological distress; specifically, Di Pietro et al, revealed that these patients are more susceptible to develop anxiety and depression, although sometimes tinnitus is a psychosomatic disorder associated to a pre-existent mental disorder<sup>(40)</sup>.

### Assessing tinnitus severity: questionnaires

There are different instruments and methods used to evaluate tinnitus severity ratings, and there is no consensus regarding their use across tinnitus treatment centers<sup>(41)</sup>. Most tinnitus questionnaires provide an index score to quantify the consequences of tinnitus on the patient's quality life. For example, individual index scores for the Tinnitus Severity Index (TSI) can range from 0 to 48 (higher scores are associated to greater severity). Instead the Tinnitus Handicap Inventory<sup>(42)</sup> places the patient into one of four "handicap severity" categories (none, mild, moderate, and severe) according to the patient's score. Surely an index score can be considered helpful to establish the need for treatment, although it couldn't provide a precise information of tinnitus severity.

The objective for any tinnitus questionnaire is to accurately identify and quantify each patient's tinnitus-associated problems. There are two primary reasons why reaching this objective has been so difficult.

First, effects of tinnitus on an individual are often multidimensional. As suggested by Tyler and Baker<sup>(37)</sup>, considering the great variability of difficulties reported by tinnitus sufferers, it's clear the complexity to create a unique questionnaire (that contains all possible questions one could ask about the distress caused by tinnitus) to obtain the correct psychological profile of the patient and his problem.

The second primary factor hindering the development of a universally effective tinnitus questionnaire is the need to properly weight the different problematic aspects of tinnitus. A question may be irrelevant to the patient's circumstances, yet the question may receive equal weight when calculating the index score<sup>(41)</sup>. If a questionnaire asks mostly irrelevant items for a particular patient, the index score might be incorrectly low.

For example, a patient's only reported problem may be difficulty falling asleep. Considering that the questionnaire used might focus more on emotional consequences of tinnitus, we would expect a low patient's index score, even if an individual

question about sleep disturbance might indicate a severe problem.

Another patient could be disturbed by tinnitus most of the day with consequences on most life activities and a resulting high index score. Both hypothetical patients have a severe problem with tinnitus but the second patient would provide an index score reflecting severe tinnitus, whereas the first patient would not.

As stated above demonstrates the difficulty to determine the real impact and severity of tinnitus. This evaluation requires an astute examiner to identify specifically how tinnitus is a problem for a patient, and to what degree. Written questionnaires, which have been documented for response validity (such as the THI), are generally helpful in this process. Furthermore, an intake interview is helpful and should be conducted by the examiner to reveal each patient's concerns, which will need to be addressed in managing the problem. The interview also can serve to provide the clinician opportunities to answer a patient's questions about the tinnitus condition.

### References

- 1) Jastreboff PJ. *Phantom auditory perception (tinnitus): mechanisms of generation and perception*. *Neurosci Res* 1990; 8: 221-254.
- 2) Quaranta A, Assennato G, Sallustio V. *Epidemiology of hearing problems among adults in Italy*. *Scandinavian Audiology* 1996; 25: 7-11.
- 3) Cespuglio D, Maggio M, Maggio O, Martines F, Martines E. *Tinnitus: epidemiology*, *Acta Medica Mediterranea*, 2005, 21: 49-51.
- 4) Deshaies P, Gonzales Z, Zenner HP, Plontke S, Paré L, Hébert S. *Quantification of the burden of disease for tinnitus caused by community noise*. Background paper. Background paper 2005; <http://www.chuq.qc.ca/oms/pdf/TinnitusBackgroundPaper2005.pdf>.
- 5) Pilgramm M, Rychlick R, Lebisch H, Siedentop H, Goebel G, Kirchhoff D. *Tinnitus in the Federal Republic of Germany: a representative epidemiological study*. Proceedings of the 6th International Tinnitus Seminar 1999. pp. 64-67, Cambridge, UK.
- 6) Dobie RA. *Depression and tinnitus*. *Otolaryngologic Clinics of North America* 2003; 36: 383-388.
- 7) Andersson G. *Tinnitus loudness matchings in relation to annoyance and grading of severity*. *Auris Nasus Larynx* 2003; 30: 129-133.
- 8) Meikle M, Taylor-Walsh E. *Characteristics of tinnitus and related observations in over 1800 tinnitus clinic patients*. *J Laryngol Otol Suppl* 1984; 9:17-21.
- 9) Heller AJ. *Classification and epidemiology of tinnitus*. *Otolaryngol Clin North Am* 2003; 36: 239-48.
- 10) Axelsson A, Ringdahl A. *Tinnitus, a study of its prevalence and characteristics*. *Br J Audiol* 1989; 23: 53-62.

- 11) Martinez F, Dispenza F, Gagliardo C, Martinez E, Bentivegna D. *Sudden sensorineural hearing loss as prodromal symptom of anterior inferior cerebellar artery infarction*. *ORL J Otorhinolaryngol Relat Spec* 2011; 73: 137-40.
- 12) Martinez F, Martinciglio G, Bucalo C, Banco A. *Neurovascular conflict in patient with tinnitus and essential hypertension: case report*. *Otorinolaringol*, 2008, 58: 191-196.
- 13) Martinez F, Pangaro A, Martinez E. *Ménière's diseases and neurovascular cross-compression: case report*. *Otorinolaringol*, 2009, 59: 65-69.
- 14) Martinez F, Bentivegna D, Maira E, Marasà S, Ferrara S. *Cavernous haemangioma of the external auditory canal: clinical case and review of the literature*. *Acta Otorhinolaryngol Ital* 2012; 32: 54-7.
- 15) Ferrara S, Di Marzo M, Martinez F, Ferrara P. *Otite media atelektasica, adesiva, timpanosclerotica: update medico e chirurgico*. *Otorinolaringol*, 2011, 61, 11-17.
- 16) Hoffman HJ, Reed GW. *Epidemiology of tinnitus. Tinnitus: Theory and Management*, J. B. Snow Jr, Ed., pp. 16-41, BC Decker, Lewiston, Me, USA, 2004.
- 17) Sindhusake D, Golding M, Newall P, Rubin G, Jakobsen K, Mitchell P. *Risk factors for tinnitus in a population of older adults: the blue mountains hearing study*. *Ear Hear* 2003; 24: 501-507.
- 18) Maggio M, Martinez F, Mucia M, Maggio O. *A Multifactorial pattern for the understanding of the psychological development of the child with impaired hearing and its clinical-therapeutic implications*. *Acta Pediatrica Mediterranea*, 2006, 22: 41-44.
- 19) Johansson MSK, Arlinger SD. *Prevalence of hearing impairment in a population in Sweden*. *International Journal of Audiology* 2003; 42: 18-28.
- 20) Fabijanska A, Rogowski M, Bartnik G, Skarzynski H. *Epidemiology of tinnitus and hyperacusis in Poland. Proceedings of the 6th International Tinnitus Seminar*, J. Hazell, Ed., pp. 569-571, The Tinnitus and Hyperacusis Centre, London, UK, 1999.
- 21) Martinez F, Bentivegna D, Martinez E, Sciacca V, Martinciglio G. *Assessing audiological, pathophysiological and psychological variables in tinnitus patients with or without hearing loss*. *Eur Arch Otorhinolaryngol* 2010; 267:1685-1693.
- 22) Savastano M. *Tinnitus with or without hearing loss: are its characteristics different?* *Eur Arch Otorhinolaryngol* 2008; 265: 1295-300.
- 23) Martinez F, Bentivegna D, Martinez E, Sciacca V, Martinciglio G. *Characteristics of tinnitus with or without hearing loss: clinical observations in Sicilian tinnitus patients*. *Auris Nasus Larynx* 2010; 37: 685-93.
- 24) Shargorodsky J, Curhan GC, Farwell WR. *Prevalence and characteristics of tinnitus among US adults*. *Am J Med* 2010; 123: 711-8.
- 25) Terao K, Cureoglu S, Schachern PA, Morita N, Nomiya S, Deroee AF, Doi K, Mori K, Murata K, Paparella MM. *Cochlear changes in presbycusis with tinnitus*. *Am J Otolaryngol* 2011; 32: 215-220.
- 26) Gristwood RE, Venables WN. *Otosclerosis and chronic tinnitus*. *Ann Otol Rhinol Laryngol* 2003; 112:398-403.
- 27) Deggouj N, Castelein S, Gerard JM, Decat M, Gersdorff M. *Tinnitus and otosclerosis*. *B-ENT* 2009; 5: 241-4.
- 28) Martinez F, Bentivegna D, Di Piazza F, Martinez E, Sciacca V, Martinciglio G. *Investigation of tinnitus patients in Italy: clinical and audiological characteristics*. *Int J Otolaryngol*. 2010; 2010: 265861.
- 29) Havia M, Kentala E, Pyykkö I. *Hearing loss and tinnitus in Meniere's disease*. *Auris Nasus Larynx* 2002; 29: 115-119.
- 30) Chole RA, Parker WS. *Tinnitus and vertigo in patients with temporomandibular disorder*. *Arch Otolaryngol Head Neck Surg* 1992; 118: 817-821.
- 31) Albuquerque Morais A, Gil D. *Tinnitus in individuals without hearing loss and its relationship with temporomandibular dysfunction*. *Braz J Otorhinolaryngol* 2012; 78: 59-65.
- 32) Dille MF, Konrad-Martin D, Gallun F, Helt WJ, Gordon JS, Reavis KM, Bratt GW, Fausti SA. *Tinnitus onset rates from chemotherapeutic agents and ototoxic antibiotics: results of a large prospective study*. *J Am Acad Audiol* 2010; 21:409-17.
- 33) B. Satar, O. Kapkin, and Y. Ozkaptan. *Evaluation of cochlear function in patients with normal hearing and tinnitus: a distortion product otoacoustic emission study*. *Kulak Burun Bogaz Ihtisas Dergisi* 2003; 10: 177-182.
- 34) Henry JA, Schechter MA, Regelein RT, Demis KC. *Veterans and tinnitus. Tinnitus: Theory and Management*, J. B. Snow Jr, Ed., pp. 337-355, McGraw Hill, New York, NY, USA, 2004.
- 35) Nicolas-Puel C, Faulconbridge RL, Guitton M, Puel JL, Mondain M, Uziel A. *Characteristics of tinnitus and etiology of associated hearing loss: a study of 123 patients*. *International Tinnitus Journal* 2002; 8: 37-44.
- 36) House PR. *Personality of the tinnitus patient*. *Ciba Found Symp* 1981; 85: 193-203.
- 37) Tyler RS, Baker LJ. *Difficulties experienced by tinnitus sufferers*. *J Speech Hear Disord* 1983; 48: 150-154.
- 38) Jakes SC, Hallam RS, Rachman S, Hinchcliffe R. *The effects of reassurance, relaxation training and distraction on chronic tinnitus sufferers*. *Behav Res Ther* 1986; 24: 497-507.
- 39) Hazell JW. *Tinnitus*. *Br J Hosp Med* 1979; 22:468-71.
- 40) Di Pietro G, Carrabba L, Giannini P, Marciano E, Speranza B, Cerruti, C, Petrosino M, Nardo MP, Valoroso L. *Evaluation of the psychopathological risk factors associated with tinnitus: A case-control study of an outpatient cohort*. *Audiological Medicine* 2007; 5: 125-128.
- 41) Newman CW, Sandridge SA. *Hearing loss is often undiscovered, but screening is easy*. *Cleve Clin J Med* 2004; 71: 225-232.
- 42) Newman CW, Sandridge SA, Jacobson GP. *Psychometric adequacy of the Tinnitus Handicap Inventory (THI) for evaluating treatment outcome*. *J Am Acad Audiol* 1998; 9: 153-160.

Request reprints from:

Dr. PIETRO SALVAGO  
Via Gioacchino Di Marzo, 37  
90144 Palermo  
(Italy)