



Brazilian Journal of Otorhinolaryngology

ISSN: 1808-8694

revista@aborlccf.org.br

Associação Brasileira de  
Otorrinolaringologia e Cirurgia Cérvico-  
Facial  
Brasil

Kumari Manche, Santoshi; Madhavi, Jangala; Raja Meganadh, Koralla; Jyothy, Akka  
Association of tinnitus and hearing loss in otological disorders: a decade-long  
epidemiological study in a South Indian population  
Brazilian Journal of Otorhinolaryngology, vol. 82, núm. 6, noviembre-diciembre, 2016, pp.  
643-649  
Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial  
São Paulo, Brasil

Available in: <http://www.redalyc.org/articulo.oa?id=392448357005>

- How to cite
- Complete issue
- More information about this article
- Journal's homepage in redalyc.org

redalyc.org

Scientific Information System

Network of Scientific Journals from Latin America, the Caribbean, Spain and Portugal  
Non-profit academic project, developed under the open access initiative



# Brazilian Journal of OTORHINOLARYNGOLOGY

[www.bjorl.org](http://www.bjorl.org)



## ORIGINAL ARTICLE

# Association of tinnitus and hearing loss in otological disorders: a decade-long epidemiological study in a South Indian population<sup>☆</sup>



Santoshi Kumari Manche<sup>a,b</sup>, Jangala Madhavi<sup>a,b</sup>, Koralla Raja Meganadh<sup>a</sup>, Akka Jyothy<sup>b,\*</sup>

<sup>a</sup> MAA ENT Hospitals, Speech and Hearing Center, Somajiguda, Hyderabad, Telangana State, India

<sup>b</sup> Osmania University, Institute of Genetics and Hospital for Genetic Diseases, Hyderabad, Telangana State, India

Received 11 August 2015; accepted 10 November 2015

Available online 13 February 2016

### KEYWORDS

Tinnitus;  
Hearing loss;  
Chronic suppurative  
otitis media;  
Otitis media  
with effusion;  
Otosclerosis

### Abstract

**Introduction:** Tinnitus is a common disorder that occurs frequently across all strata of population and has an important health concern. Tinnitus is often associated with different forms of hearing loss of varying severity.

**Objective:** The present study aimed to identify the association of tinnitus with hearing loss in various otological disorders of a South Indian population.

**Methods:** A total of 3255 subjects referred to the MAA ENT Hospital, Hyderabad, from 2004 to 2014, affected with various otological diseases have been included in the present cross-sectional study. Diagnosis of the diseases was confirmed by an ear, nose, and throat (ENT) specialist using detailed medical and clinical examination. Statistical analysis was performed using the  $\chi^2$  test and binary logistic regression.

**Results:** Tinnitus was observed in 29.3% (956) of the total study subjects that showed an increased prevalence in greater than 40 years of age. There was a significant increase in risk of tinnitus with middle (OR = 1.79, 95% CI = 1.02–3.16) and inner (OR = 3.00, 95% CI = 1.65–5.45) inner ear diseases. It was noted that 96.9% ( $n = 927$ ) of the tinnitus subjects was associated with hearing loss. Otitis media (60.9%), presbycusis (16.6%) and otosclerosis (14.3%) are the very common otological disorders leading to tinnitus. Tinnitus was significantly associated with higher degree of hearing loss in chronic suppurative otitis media (CSOM) subjects.

**Conclusion:** The present study could identify the most prevalent otological risk factors leading to development of tinnitus with hearing loss in a South Indian population.

© 2016 Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. Published by Elsevier Editora Ltda. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<sup>☆</sup> Please cite this article as: Manche SK, Madhavi J, Meganadh KR, Jyothy A. Association of tinnitus and hearing loss in otological disorders: a decade-long epidemiological study in a South Indian population. Braz J Otorhinolaryngol. 2016;82:643–9.

\* Corresponding author.

E-mail: [jyothycell@rediffmail.com](mailto:jyothycell@rediffmail.com) (A. Jyothy).

**PALAVRAS-CHAVE**

Zumbido;  
Perda auditiva;  
Otite média  
supurativa crônica;  
Otite média com  
efusão;  
Otosclerose

**Associação de zumbido e perda auditiva em distúrbios otológicos: estudo epidemiológico de uma década em uma população do Sul da Índia****Resumo**

**Introdução:** O zumbido é um distúrbio comum que ocorre com frequência em todos os estratos da população, constituindo um problema importante de saúde. O zumbido é frequentemente associado a diferentes formas de perda auditiva e sua gravidade é variada.

**Objetivo:** O presente estudo teve como objetivo identificar a associação entre zumbido e perda auditiva em várias doenças otológicas na população do Sul da Índia.

**Método:** No total, 3.255 indivíduos encaminhados ao Hospital MAA ENT em Hyderabad de 2004 a 2014, com diversas doenças otológicas, foram incluídos neste estudo transversal. O diagnóstico das doenças foi confirmado pelo otorrinolaringologista por meio de exames médico e clínico detalhados. A análise estatística foi realizada com o teste do  $\chi^2$  e regressão logística binária.

**Resultados:** Zumbido foi observado em 29,3% (956) do total de participantes do estudo, com maior prevalência em indivíduos com mais de 40 anos de idade. Houve um aumento significativo do risco de zumbido em doenças da orelha média (OR = 1,79, IC 95% = 1,02-3,16) e interna (OR = 3,00, IC 95% = 1,65-5,45). Observamos que em 96,9% (n = 927) dos indivíduos com zumbido houve associação com perda auditiva.

**Conclusão:** O presente estudo pôde identificar os fatores etiológicos mais prevalentes que levam ao desenvolvimento de zumbido associado à perda auditiva em uma população do Sul da Índia. Otite média (60,9%), presbiacusia (16,6%) e otosclerose (14,3%) são doenças otológicas frequentemente associadas ao zumbido. Em indivíduos com otite média crônica supurativa (OMCS), o zumbido foi significativamente associado ao maior grau de perda auditiva.

© 2016 Associação Brasileira de Otorrinolaringologia e Cirurgia Cérvico-Facial. Publicado por Elsevier Editora Ltda. Este é um artigo Open Access sob uma licença CC BY-NC-ND (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

**Introduction**

Tinnitus is a perceptual expression of any sound that originates in an involuntary manner, either unilaterally or bilaterally, in the absence of any external acoustic or electric stimulus.<sup>1,2</sup> The etiology of tinnitus remains unknown, but some underlying clinical causes such as middle-ear diseases, nasal allergies, autoimmunity, cardiovascular diseases, diabetes, degenerative neural disorders, socio-demographic, and environmental factors have been reported.<sup>2-5</sup> Many clinical studies have reported that otological disorders causes changes in the cochlear structures or neuroplastic alterations in the central auditory pathways, leading to tinnitus.<sup>2,4,6,7</sup> Globally, about 10–15% of the general population is expected to be affected with tinnitus, with or without concomitant hearing impairment.<sup>4,8</sup> Moreover, the prevalence of tinnitus correlates with the severity and frequency characteristics of the hearing loss.<sup>4,9</sup> Further, tinnitus is present in 70–85% of hearing impairment caused by different pathologies of the auditory system.<sup>2,5,10</sup> In India, it is estimated that approximately 4.5 million people are affected with tinnitus; unfortunately there are no exact data available on the prevalence and etiology of tinnitus.<sup>11</sup> Therefore, the present study aimed to establish the prevalence and to identify the potential predisposing factors leading to tinnitus and hearing loss in a South Indian population.

**Methods****Subjects**

In the present cross-sectional study, a total of 3255 patients with different otological diseases referred to MAA ENT Hospitals, Hyderabad, Telangana State, over a period of 10 years from 2004–2014 constituted the study subjects. All patients underwent a detailed medical examination and clinical history was recorded. Audiometric thresholds of hearing loss were evaluated using pure tone average for the frequencies 0.5, 1, 2, 4 and 8 kHz. The study has been carried out with institutional ethics committee clearance.

**Statistical analysis**

The data obtained was coded for statistical evaluations. Appropriate statistical analysis was performed using PASW STATISTICS 18.0 (SPSS Inc. – Chicago, IL, United States). Continuous data is represented as means and standard deviations, whereas categorical data as proportions. The  $\chi^2$  test was used to compare the proportions, while binary logistic regression analysis was performed for association of categorical variables.

**Table 1** Clinical and demographic findings in subjects affected with tinnitus among otological disorders.

Characteristics	Otological diseases (n = 3255)	Percentage	Tinnitus subjects (n = 956)	Percentage	OR (95% CI) <sup>a</sup>
<i>Sex</i>					
Females	1353	41.6	428	31.6	1.20 (1.03–1.40) <sup>b</sup>
Males	1902	58.4	528	27.8	Reference
<i>Age of onset (years)</i>					
>40	2071	63.6	551	26.6	1.45 (1.27–1.73) <sup>c</sup>
0–40	1184	36.4	405	34.2	Reference
<i>Site of disease</i>					
Outer ear	83	2.6	15	18.1	Reference
Middle ear	2808	86.3	796	28.4	1.79 (1.02–3.16) <sup>b</sup>
Inner ear	364	11.2	145	39.8	3.00 (1.65–5.45) <sup>c</sup>
<i>Laterality of ear</i>					
Bilateral	1338	41.1	402	30.0	1.06 (0.91–1.23)
Unilateral	1917	58.9	554	28.9	Reference
<i>Types of hearing loss</i>					
Normal hearing	144	4.4	29	20.1	Reference
Conductive hearing loss	2254	69.2	599	26.6	1.44 (0.95–2.18)
Sensorineural hearing loss	540	16.6	201	37.2	2.35 (1.51–3.66) <sup>c</sup>
Mixed hearing loss	317	9.7	127	40.1	2.65 (1.67–4.22) <sup>c</sup>
<i>Predisposing factors</i>					
Otological only	1906	58.6	610	32.0	Reference
Otological + nas opharyngeal	1188	36.5	290	24.4	0.69 (0.58–0.81) <sup>c</sup>
Otological + metabolic disorders	161	4.9	56	34.7	1.13 (0.81–1.59)

n, Frequency; 95% CI, 95% confidence interval; OR, odds ratio.

<sup>a</sup> Binary logistic regression analysis.

Level of significance of odds ratio: <sup>b</sup>p-value < 0.05, <sup>c</sup>p-value < 0.001.

## Results

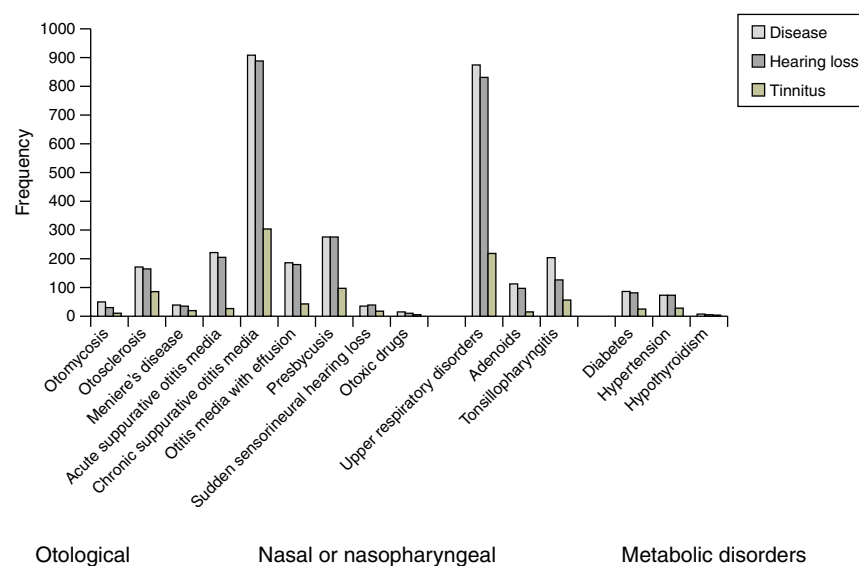
Among the 3255 study subjects with otological diseases, 58.6% (n = 1906) were affected with ear-only diseases, 36.5% (n = 1188) with nasal or nasopharyngeal and 4.9% (n = 161) with metabolic disorders. Increase in prevalence of middle ear otological diseases i.e., 86.2% (n = 2808), compared to inner ear 11.2% (n = 364) and outer ear diseases 2.6% (n = 83) was observed. The patients were aged between 7 and 83 years with a mean age of 36.0 ± 18.94 with 58.4% (n = 1902) males and 41.6% (n = 1353) females. The prevalence of tinnitus was found to be 29.4% (n = 956) among the study subjects.

The percentage of tinnitus subjects affected with only ear ailments was 63.8% (n = 610), nasal or nasopharyngeal was 30.3% (n = 290), and metabolic disorders was 5.9% (n = 56). The onset of tinnitus was at mean age of 32.2 ± 20.45 and a significant increase in risk was seen in the age group >40 years (OR = 1.45; 95% CI = 1.27–1.73). Among the tinnitus subjects, 55.2% (n = 528) were males and 44.8% (n = 428) were females, with increased male preponderance of 1.23. However, significant increase in risk for females was observed (OR = 1.20; 95% CI = 1.03–1.40). The occurrence of tinnitus was found to be more of unilateral (58.0%) than bilateral (42.0%). However, no significant association was observed between tinnitus and laterality. The distribution

of sex, age of onset, site of disease, laterality, type of hearing loss, and predisposing factors is represented in [Table 1](#).

Risk of tinnitus was found to be significantly increased in subjects affected with inner ear 39.8% (OR = 3.00; 95% CI = 1.65–5.45), followed by middle ear diseases 28.4% (OR = 1.79; 95% CI = 1.02–3.16). Among the inner ear diseases, presbycusis (16.6%), Meniere's disease (3.3%), and sudden sensorineural hearing loss (SSNHL) (2.8%) were more prevalent. Chronic suppurative otitis media (CSOM) was found in 49.6%, otosclerosis in 14.2%, and otitis media with effusion (OME) in 7% of otological disorders, contributing to tinnitus in the middle ear. Among the other predisposing factors, upper respiratory disorders contributed to 69.4%, tonsillopharyngitis 10.6%, hypertension 2.9%, and diabetes 2.6% for tinnitus cases ([Fig. 1](#)).

In the present study, the prevalence of hearing loss with tinnitus was 29.8% (n = 927). The prevalence of various otological diseases predisposing to tinnitus is depicted in [Fig. 1](#). The predisposing factors such as CSOM, OME, otomycosis, and Meniere's disease were associated with higher frequency (>40 dB) of hearing loss in tinnitus subjects ([Table 2](#)). However, a significant association was noticed only in CSOM (OR = 1.76; 95% CI = 1.32–2.38). Further it is also observed that other predisposing factors were also associated at higher frequency of hearing loss. Among them,



**Figure 1** Prevalence of tinnitus and hearing loss in otological diseases.

tonsillopharyngitis showed statistical significance (OR = 2.86; 95% CI = 1.46–5.59) (Table 2).

With regard to pattern of hearing loss, conductive type was observed in 62.6% ( $n=599$ ), sensorineural in 21.0% ( $n=201$ ) and mixed type in 13.3% ( $n=127$ ) of tinnitus cases (Table 3). It was observed that there is a significant association of tinnitus with sensorineural (37.2%) and mixed hearing loss (40.1%) when compared to conductive hearing loss (26.6%) (Table 1, Fig. 1). High prevalence of

sensorineural and mixed hearing loss was observed in tinnitus cases affected with otitis media (Table 3).

## Discussion and conclusion

Tinnitus is a common disorder which occurs frequently across all strata of population and exhibits an important health concern. Clinical and epidemiological studies on tinnitus have revealed that 5–32% of the world population is affected

**Table 2** Degree of hearing loss in subjects with and without tinnitus in otological disorders.

Disease condition	Hearing loss with tinnitus		Hearing loss without tinnitus		OR (95% CI) <sup>a</sup>
	<40 dB n (%)	>40 dB n (%)	<40 dB n (%)	>40 dB n (%)	
<i>Otological</i>					
Otomycosis	3 (37.5)	5 (62.5)	14 (63.6)	8 (36.4)	3.33 (0.81–13.75)
Otosclerosis	20 (24.1)	63 (75.9)	13 (15.3)	72 (84.7)	0.54 (0.26–1.14)
Meniere's disease	11 (57.9)	8 (42.1)	12 (70.6)	5 (29.4)	1.73 (0.44–6.79)
Acute suppurative otitis media	19 (79.2)	5 (20.8)	154 (85.1)	27 (14.9)	1.50 (0.52–4.36)
Chronic suppurative otitis media	184 (61.5)	115 (38.5)	436 (73.9)	154 (26.1)	1.76 (1.32–2.38) <sup>c</sup>
Otitis media with effusion	22 (52.4)	20 (47.6)	94 (67.1)	46 (32.9)	1.83 (0.92–3.67)
Presbycusis	18 (17.8)	83 (82.2)	35 (20.0)	140 (80.0)	1.15 (0.61–2.16)
Sudden sensorineural hearing loss	2 (11.8)	15 (88.2)	3 (15.0)	17 (85.0)	1.32 (0.19–9.02)
Ototoxic drugs	1 (50.0)	1 (50.0)	10 (83.3)	2 (16.7)	5.50 (0.24–128.97)
<i>Nasal or nasopharyngeal</i>					
Upper respiratory disorders	140 (66.4)	71 (33.6)	430 (70.1)	183 (29.9)	1.21 (0.87–1.68)
Adenoids	13 (100.0)	0 (0.0)	70 (71.4)	28 (28.6)	NA
Tonsillopharyngitis	30 (56.6)	23 (43.4)	98 (77.2)	29 (22.8)	2.86 (1.46–5.59) <sup>b</sup>
<i>Co-morbidities</i>					
Diabetes	13 (52.0)	12 (48.0)	34 (59.6)	23 (40.4)	1.41 (0.55–3.61)
Hypertension	15 (55.6)	12 (44.4)	31 (70.5)	13 (29.5)	1.79 (0.67–4.81)
Hypothyroidism	2 (66.7)	1 (33.3)	2 (66.7)	1 (33.3)	1.00 (0.03–29.81)

n, Frequency; OR, odds ratio; 95% CI, 95% confidence interval; NA, not applicable.

<sup>a</sup> Binary logistic regression analysis.

Level of significance of odds ratio: <sup>b</sup> $p$ -value < 0.01, <sup>c</sup> $p$ -value < 0.001.

**Table 3** Pattern of hearing loss in subjects with and without tinnitus in otological disorders.

Disease condition	Hearing loss pattern in patients with tinnitus			Hearing loss pattern in patients without tinnitus			p-Value <sup>a</sup>
	Conductive n (%)	Sensorineural n (%)	Mixed n (%)	Conductive n (%)	Sensorineural n (%)	Mixed n (%)	
<i>Otological</i>							
Otomycosis	4 (50.0)	1 (12.5)	3 (37.5)	19 (86.4)	2 (9.1)	1 (4.5)	0.05
Otosclerosis	55 (66.3)	13 (15.7)	15 (18.1)	61 (71.8)	8 (9.4)	16 (18.8)	0.47
Meniere's disease	13 (68.4)	5 (26.3)	1 (5.3)	11 (64.7)	6 (35.3)	0 (0.0)	NA
Acute suppurative otitis media	18 (75.0)	5 (20.8)	1 (4.2)	162 (89.5)	12 (6.6)	7 (3.9)	0.06
Chronic suppurative otitis media	234 (78.3)	20 (6.7)	45 (15.1)	511 (86.6)	32 (5.4)	47 (8.0)	0.03 <sup>b</sup>
Otitis media with effusion	28 (66.7)	8 (19.0)	6 (14.3)	120 (85.7)	12 (8.6)	8 (5.7)	0.02 <sup>b</sup>
Presbycusis	0 (0.0)	101 (100.0)	0 (0.0)	0 (0.0)	175 (100.0)	0 (0.0)	NA
Sudden sensorineural hearing loss	0 (0.0)	17 (100.0)	0 (0.0)	0 (0.0)	20 (100.0)	0 (0.0)	NA
Ototoxic drugs	2 (100.0)	0 (0.0)	0 (0.0)	11 (91.7)	1 (8.3)	0 (0.0)	NA
<i>Nasal or nasopharyngeal</i>							
Upper respiratory tract infections	13 (52.0)	3 (12.0)	9 (36.0)	37 (64.9)	9 (15.8)	11 (19.3)	0.27
Adenoids	12 (92.3)	0 (0.0)	1 (7.7)	85 (86.7)	5 (5.1)	8 (8.2)	NA
Tonsillopharyngitis	38 (71.7)	10 (18.9)	5 (9.4)	106 (83.5)	12 (9.4)	9 (7.1)	0.16
<i>Metabolic disorders</i>							
Diabetes	13 (52.0)	3 (12.0)	9 (36.0)	37 (64.9)	9 (15.8)	11 (19.3)	0.27
Hypertension	13 (48.1)	7 (25.9)	7 (25.9)	32 (72.7)	4 (9.1)	8 (18.2)	0.78
Hypothyroidism	2 (66.7)	0 (0.0)	1 (33.3)	3 (100)	0 (0.0)	0 (0.0)	NA

n, Frequency; NA, not applicable.

<sup>a</sup>  $\chi^2$  test.

Level of significance of odds ratio: <sup>b</sup>p-value < 0.05.

with tinnitus.<sup>2,12,13</sup> Many risk factors associated with onset of tinnitus have been reported, of which the most prominent are age, gender, auditory, metabolic and neurological disorders, vascular alterations, dental factors, exposure to noise, ototoxic drugs, caffeine, nicotine, and alcohol.<sup>4,8,9,14</sup> Otological disorders are the most common cause of tinnitus.<sup>15</sup> Various otological diseases can lead to tinnitus and different types of hearing loss. This is due to infection or stiffening of bones or spasms of one of the two tiny muscles attached to bones of the middle ear, which affects the sound transmission system in the ear.<sup>9,16,17</sup> Furthermore, various nasopharyngeal factors are involved in Eustachian tube dysfunction, predisposing to middle ear infections. In the present study, 29.3% of the otological disorders were affected with tinnitus, of which 30.3% were affected with nasal or nasopharyngeal factors especially tonsillopharyngitis in particular causing Eustachian tube dysfunction and middle ear infection leading to hearing loss and tinnitus, probably through lymphatic spread. However this needs to be further studied.

Many studies conducted on tinnitus have reported high male preponderance, which was mainly attributed to high environmental and occupational exposure.<sup>2,18,19</sup> However, higher female preponderance of tinnitus has also been reported by a few studies.<sup>20</sup> In the present study, tinnitus has been found to affect both males and females, but with a high male preponderance, which is due to the greater number of male subjects visiting the hospital when compared to females. However, it was also noticed that there was a significant increase in female cases for the treatment at the chronic stage of ear diseases/tinnitus.

The onset of tinnitus is reported to have a strong association with increasing age but it was also found to be present in younger age.<sup>5,6,16,21</sup> Differences in the onset of tinnitus are due to ethnicity, age variation, and the diagnostic criteria that have been taken into consideration.<sup>5,22,23</sup> In the present study, higher prevalence of tinnitus has been discovered in the age group greater than 40 years. Changes in life style, abnormality at the metabolic level, and a high incidence of predisposing factors of metabolic diseases experienced

by the elderly people are reported to cause tinnitus. Moreover, increased level of insulin resistance and some drugs used for the treatment of hypertension worsen the resistance and can favor tinnitus onset.<sup>21,24</sup> In the present study, tinnitus was observed in 30.1% of patients with diabetes mellitus, 38.8% in hypertension and 40% with hypothyroidism. Medications such as salicylates, aminoglycoside antibiotics, quinine, or cisplatin used to treat otological and nasopharyngeal diseases can cause damage to the cochlea and trigger or enhance tinnitus.<sup>1,25,26</sup> It was found that 13.3% of ototoxicity cases contributed to tinnitus in the present study.

Hearing loss and tinnitus are closely related, as the prevalence of hearing loss is higher in tinnitus cases.<sup>5,24</sup> In the present study, 96.9% of cases with tinnitus have a significant association with hearing loss, indicating it as one of the crucial risk factors. Moreover, the occurrence of hearing loss at higher frequencies in tinnitus subjects indicates the severity of suffering caused due to otological disorders.<sup>27,28</sup> Further, auditory pathology in middle and inner parts of ear can lead to different pattern of hearing loss. Interestingly, in the present study it was observed that conductive form is the most common cause of hearing loss and tinnitus when compared to sensorineural hearing loss. In addition, middle ear diseases in this study were more compromised than the inner ear, unlike other studies.<sup>29,30</sup> This variation could be attributed to geographical distribution and socioeconomic status. Further, in the present study 95% of middle ear diseases obtained relief from hearing loss and 86% from tinnitus after treatment with surgical and medical interventions. In the present study, there was a significant increase in hearing loss at higher frequency with sensorineural and mixed type in tinnitus subjects with CSOM. The results indicate CSOM as one of the most common otological diseases affecting the middle and inner ear leading to tinnitus and hearing loss.

In conclusion, the present study indicates otitis media, presbycusis, and otosclerosis are the most common contributing factors leading to tinnitus and hearing loss. The prevalence of tinnitus increased with the progression of the otological disorders. Hence, efforts to control these risk factors may help in ameliorating tinnitus and improving quality of life of the affected individuals. Further studies on the genetics of tinnitus associated with hearing loss will undoubtedly lead to effective therapeutic approaches and clinical management of tinnitus.

## Conflicts of interest

The authors declare no conflicts of interests.

## Acknowledgements

The authors thank Mrs. B. Sunita G Kumar, CMD, MAA ENT Hospitals for her support and cooperation in carrying out the work. We also thank Dr. Balakrishna of NIN for providing support in performing the statistical analysis.

## References

1. Baguley DM. Mechanisms of tinnitus. *Br Med Bull*. 2002;63:195–212.
2. Heller AJ. Classification and epidemiology of tinnitus. *Otolaryngol Clin N Am*. 2003;36:239–48.
3. Vernon JA, Meikle MB. Measurement of tinnitus: an update. In: Kitahara M, editor. *Tinnitus: pathophysiology and management*. Tokyo: Igaku-Shoin; 1988. p. 36–52.
4. 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;24:501–7.
5. Hoffman HJ, Reed GW. Epidemiology of tinnitus. In: Snow JB, editor. *Tinnitus: theory and management*. Lewiston, NY: BC Decker; 2004. p. 16–41.
6. Chung DY, Gannon RP, Mason K. Factors affecting the prevalence of tinnitus. *Audiology*. 1984;23:441–52.
7. Schecklmann M, Vielsmeier V, Steffens T, Landgrebe M, Langguth B, Kleinjung T. Relationship between audiometric slope and tinnitus pitch in tinnitus patients: insights into the mechanisms of tinnitus generation. *PLoS ONE*. 2012;7:e34878.
8. Steinmetz LG, Zeigelboim BS, Lacerda AB, Morata TC, Marques JM. Evaluating tinnitus in industrial hearing loss prevention programs. *Int Tinnitus J*. 2008;14:152–8.
9. Dobie RA. Overview: suffering from tinnitus. In: Snow JB, editor. *Tinnitus: theory and management*. Lewiston, NY: BC Decker; 2004. p. 1–7.
10. Jastreboff PJ, Hazell JW. A neurophysiological approach to tinnitus: clinical implications. *Br J Audiol*. 1993;27:7–17.
11. Vempati A, Prakash SGR, Rathna SB, Sandhya K. Management options for individuals with tinnitus – a review. *Int J Sci Res*. 2013;2:290–4.
12. Quaranta A, Assennato G, Sallustio V. Epidemiology of hearing problems among adults in Italy. *Scand Audiol Suppl*. 1996;42:9–13.
13. Pilgramm M, Rychlick R, Lebisch H, Siedentop H, Goebel G, Kirchhoff D. Tinnitus in the Federal Republic of Germany: a representative epidemiological study. In: Hazell J, editor. *Proceedings of the 6th International Tinnitus Seminar*. Cambridge, London: The Tinnitus and Hyperacusis Centre; 1999. p. 64–7.
14. Schleuning AJ. Management of the patient with tinnitus. *Med Clin N Am*. 1991;75:1225–37.
15. Crummer R, Ghinwa H. Diagnostic approach to tinnitus. *Am Fam Phys*. 2004;69:120–6.
16. Coles RRA. Classification of causes, mechanisms of patient disturbance, and associated counseling. In: Vernon JA, Moller AR, editors. *Mechanisms of tinnitus*, 75. Needham Heights, MA: Allyn & Bacon; 1995. p. 1225–37.
17. Weber PC, Klein AJ. Hearing loss. *Med Clin N Am*. 1999;83:125–37.
18. Fabijanska A, Rogowski M, Bartnik G, Skarzynski H. Epidemiology of tinnitus and hyperacusis in Poland. In: Hazell JWP, editor. *Proceedings of the 6th International Tinnitus Seminar*. London: The Tinnitus and Hyperacusis Centre; 1999. p. 569–71.
19. Johansson MS, Arlinger SD. Prevalence of hearing impairment in a population in Sweden. *Int J Audiol*. 2003;42:18–28.
20. Cooper JC. Health and Nutrition Examination Survey of 1971–75: Part II. Tinnitus, subjective hearing loss, and well-being. *J Am Acad Audiol*. 1994;5:37–43.
21. Davis A, Rafaie EA. Epidemiology of tinnitus. In: Tyler RS, editor. *Tinnitus handbook*. San Diego: Singular; 2000. p. 1–23.
22. Podoshin L, Ben-David J, Teszler CB. Pediatric and geriatric tinnitus. *Int Tinnitus J*. 1997;3:101–3.
23. Terao K, Cureoglu S, Schachern PA, Morita N, Nomiya S, Deroee AF, et al. Cochlear changes in presbycusis with tinnitus. *Am J Otolaryngol*. 2011;32:215–20.
24. Nondahl DM, Cruickshanks KJ, Wiley TL, Klein BE, Klein R, Chappell R, et al. The ten-year incidence of tinnitus among older adults. *Int J Audiol*. 2010;49:580–5.

25. Fausti SA, Henry JA, Frey AH. Ototoxicity. In: Northern JL, editor. Hearing disorders. Needham Heights, MA: Allyn & Bacon; 1995. p. 149–64.
26. Folmer RL, Griest SE. Tinnitus and insomnia. *Am J Otolaryngol.* 2000;21:287–93.
27. Baskill JL, Coles RRA. Relationship between tinnitus loudness and severity. In: Hazell JJ, editor. Sixth International Tinnitus Seminar. Cambridge, United Kingdom: The Tinnitus and Hyperacusis Centre; 1999. p. 424–8.
28. Weisz N, Voss S, Berg P, Elbert T. Abnormal auditory mismatch response in tinnitus sufferers with high-frequency hearing loss is associated with subjective distress level. *BMC Neurosci.* 2004;5:8–16.
29. Savastano M. Tinnitus with or without hearing loss: are its characteristics different? *Eur Arch Otorhinolaryngol.* 2008;265:1295–300.
30. Martines F, Bentivegna D, Di Piazza F, Martines E, Sciacca V, Martinciglio G. Investigation of tinnitus patients in Italy: clinical and audiological characteristics. *Int J Otolaryngol.* 2010;2010:265861.