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Demographic Variations in Tinnitus Subjects with and without Hearing Loss: A Study of 175 Subjects

Anuradha Sharma[1]
Sanjay Munjal[1]
Naresh Panda[2]
Manju Mohanty[3]

Abstract

Objectives: This research was conducted to investigate the presenting features of tinnitus in subjects with normal hearing thresholds as compared to the ones with hearing loss.

Methodology: Sample population comprised of 175 subjects with tinnitus, in the age range of 18 to 55 years, segregated into two groups: G1 (75 subjects) having normal hearing with tinnitus and G2 (100 subjects) having hearing loss with tinnitus. All the subjects underwent conventional audiometric testing along with a thorough evaluation of all the parameters of tinnitus.

Results and Conclusion: Significantly large number of males reported with tinnitus as compared to females. Tinnitus was most prevailing in left ear and these subjects sought intervention earlier than right tinnitus subjects. G1 subjects reported earlier as compared to G2 subjects. Males looked out for specialist's advice earlier than females in both the groups. Large number of subjects in both groups reported with sudden onset and continuous tinnitus.

Keywords: tinnitus, sensorineural hearing loss, demographics, pure tone thresholds, tinnitus symptoms, personal perception.

[1]Department of Otolaryngology, Speech and Hearing Unit, New OPD, PGIMER, Sector 12, Chandigarh, India
[2]Department of Otolaryngology, PGIMER, Chandigarh, India
[3]Department of Neurosurgery, PGIMER, Chandigarh, India
Send correspondence to:
Anuradha Sharma
Lecturer, Department of Otolaryngology, Speech and Hearing Unit, New OPD, PGIMER, Sector 12, Chandigarh, Punjab, India. E-mail: anuradha2ks@yahoo.com
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INTRODUCTION

Tinnitus is the sensation of sound, without its existence in the external environment. Many researchers have described that tinnitus would be experienced by at least one-third of the population in their life span[1,2]. Sustained tinnitus can interfere and hamper the social, professional and psychological aspects and acutely influences the quality of life[3,4].

It is generally associated with hearing loss, but can also be observed in patients having a clinically normal hearing[5-8]. Literature reports approximately 24%, 35% and 41% cases of tinnitus due to irregularities in the inner ear and vestibulo-cochlear nerve, auditory pathway, and supratentorial structures respectively. Hyperactivity and hypersensitivity associated with tinnitus originate because of hair cell injuries, which in turn leads to a lesser input to the cortex, and reduced inhibitory signal to the post synaptic neuron, and increased signal to the excitatory ones[9].However few studies have also emphasized, that "neural activity that leads to tinnitus may originate in the nervous system, with and without the involvement of ear"[8].

Studies have also enlisted that alteration of "balance between inhibition and excitation, reorganization of neuronal networks, changes in tonotopic maps, and rerouting of information" are the changes in the auditory nervous system that could lead to tinnitus[8]. As an evident, the exhaustive research on the origin of tinnitus has led to inconclusive results.

What is confusing to clinicians is that why subjects with or without hearing loss demonstrate a broad spectrum of responses to tinnitus. Some subjects could have intrusive and disabling effects whereas others may not perceive it that way. It has been reported that some subjects have adaptive changes at cortical and sub cortical level that preserve the tinnitus if they attend to it[10]. These adaptive changes may heighten following an emotional response, and the threat of tinnitus would increase by the level of attention directed towards it[10,11]. Tinnitus is also, related to psychological stress which in turn is associated with cortisol reactivity and is found to be diminished in tinnitus sufferers[12]. Researchers have also proclaimed increased levels of loudness, mask ability and greater discomfort in subjects with hearing loss and tinnitus in comparison to normal hearing and tinnitus[13]. Literature has greatly focused on the hearing evaluations in tinnitus and very few studies have concentrated on variability in tinnitus characteristics and factors associated with tinnitus, (the primitive signs of disease) which could act as predictive variables.

Also, the literature on the onset, course, and nature of tinnitus among the normal hearing and the hearing loss group is sparse. Besides, the gender variations and effect of tinnitus on each ear, the relationship between these tinnitus characteristics and these variables would facilitate understanding of mechanisms responsible for the generation of tinnitus[14]. It has also become evident that development and selection of treatment program to alleviate tinnitus would depend on identifying the factors that are contributing to the deterioration in the quality of life of tinnitus subjects. Thus, this study was conducted in order to determine whether any differences exist between the two tinnitus groups on various clinical demographics.

METHODOLOGY

The study was conducted on 175 subjects with tinnitus, with an age range of 16 to 55 years, who reported to Speech and Hearing unit (Department of ENT) between 2013-2016. A prior approval from the institute's ethics committee was priorly obtained and also an informed consent form was duly filled by each participant. A thorough medical examination was conducted for subjects to rule out any other health diseases, psychiatric illness, and systemic disorder, and to ascertain any tinnitus related pathologies. Following a thorough otolaryngological examination, subjects with any middle ear pathology, or mobile phone usage for more than two hours per day were excluded from the study.

All the subjects were administered with a history questionnaire and routine audiometric evaluation. The order in which these tests were administered was randomized.

Sample population

All the subjects had reported to the tertiary care hospital with complaints of tinnitus with or without hearing loss. Subjects were grouped as G1 'normal hearing with tinnitus' (N=75) and G2 'hearing loss with tinnitus' (N=100), in which subjects with mild to moderate sensorineural hearing loss only were enrolled in the study.

Pure tone audiometry

All the participants underwent pure tone audiometry on Madsen Orbiter 922 clinical audiometer. Pure tone thresholds were recorded at 250 Hz, 500 Hz, 1 KHz, 2 KHz, 4 KHz, and 8 KHz. Pure tone average was taken for frequencies 500 Hz,1 KHz,2 KHz ,and pure tone average below 25 dBHL was considered as normal hearing and 25 dB-40 dBHL as the mild hearing loss, whereas 40-55 dBHL was considered as the moderate hearing loss.

Demographics

The items in questionnaire addressed the age, gender, duration, onset and nature of tinnitus. The data collected included tinnitus laterality (right, left and bilateral), tinnitus duration (0-3 months, 3-6 months, 6 months-1 year, 1-2 years, 2-3 years and greater than 3 years), onset of tinnitus (sudden or gradual), course of tinnitus (progressive, static and fluctuating) and nature of tinnitus (continuous, intermittent and fluctuating)

The statistical analysis was performed using SPSS version 23 and Minitab 17 statistical software.

RESULTS

The current study had 175 adults, in which G1 had 75 and G2 had 100, having 56% males and 44% females in the normal hearing with tinnitus group and 70% males and 30% females in hearing loss with tinnitus group ($p<0.05$). The descriptive analysis (frequency and percentage) and Chi-square values indicated that larger number of males reported in both groups as compared to females. The mean age of subjects in G1 and G2 was 43.02 (10.61) and 39.36 (10.11) years respectively. The two groups were matched for age (Table 1).

Intragroup comparison of tinnitus ears

Categorization of 175 patients based on tinnitus characteristics revealed that both normal hearing with tinnitus (G1) and hearing loss with tinnitus (G2) group had a large number of subjects having tinnitus in left ear (52 and 77), as shown in Table 2. The subjects with bilateral tinnitus were clubbed into both left and right ear tinnitus groups respectively, hence the number of right and left tinnitus ears in G1 were 46 and 52; and in G2 were 62 and 77 respectively.

The outcome of the descriptive statistics and Z test of proportionality revealed that there were no significant differences between right and left ear tinnitus subjects within G1 and G2 group on the duration of tinnitus, onset of tinnitus and nature of tinnitus. However, in-depth exploration revealed that in G1, larger number of subjects with tinnitus reported within the time frame of less than one year (23.9% in right ear and 23.7% in left ear), whereas in G2, right tinnitus subjects had reported far later to left tinnitus ears (large number of right ear hearing loss with tinnitus reported after 1 to 2 years of duration (27.4%) whereas majority (22.1%) of left ear hearing loss with tinnitus subjects reported within time frame of six months) (Table 2).

The onset of tinnitus was sudden in the majority of subjects in both groups. In G1, 95.3% and 92.3% subjects presented with sudden onset of tinnitus in right ear and left ear respectively, which was continuous in nature and remained unchanged over time. In G2, 93.5% of right and 94.8% of left ear tinnitus subjects reported sudden onset of tinnitus, whereas it was continuous and remained unchanged thereafter in the majority of cases.

Inter group comparison of tinnitus ears

There were no significant differences observed between right and left tinnitus ears of the G1 and G2 groups. However, the results highlighted that higher proportion of normal hearing with tinnitus group (67.3% right ear and 57.64% left ear) reported within one year than the hearing loss with tinnitus group (45.1% right and 58.5% left ear respectively) (Table 3).

Intra group gender comparisons

Z test of proportionality was applied to the data, due to the disparity in the number of male versus female subjects in hearing loss with tinnitus group (Table 4).

Table 1. Comparison of "Sex" variable between G1 and G2 group.

Sex	Normal hearing with tinnitus Frequency (percentage)	Hearing loss with tinnitus Frequency (percentage)	Chi-square (P value)
Male	42 (56%)	70 (70%)	0.056
Female	33 (44%)	30 (30%)	

G1=group 1 (Normal hearing with tinnitus group), G2=group 2 (Hearing loss with tinnitus group).

Table 2. Comparison of tinnitus subjects with normal hearing and hearing loss on clinical characteristics.

Clinical characteristics	G1=Normal hearing with tinnitus group			G2=Hearing loss with tinnitus		
	Right ear, N=46	Left ear, N=52	Z test of proportionality (P value)	Right ear, N=62	Left ear, N=77	Z test of proportionality (P value)
Duration of tinnitus						
<3 months	9 (19.5%)	12 (23.07%)	0.806	10 (16.1%)	16 (20.8%)	0.52
3-6 months	11 (23.9%)	6 (11.5%)	0.115	11 (17.7%)	17 (22.1%)	0.671
6 months-1 year	1 1(23.9%)	12 (23.07%)	0.23	7 (11.3%)	12 (15.6%)	0.62
1-2 years	7 (15.2%)	10 (19.2%)	0.79	17 (27.4%)	15 (19.5%)	0.313
2-3 years	1 (2.1%)	3 (5.7%)	0.62	4 (6.5%)	6 (7.8%)	1
>3 years	7 (15.2%)	9 (17.3%)	1	13 (21%)	11 (14.3%)	0.368
Onset of tinnitus						
Sudden	44 (95.6%)	48 (92.3%)	0.68	58 (93.5%)	73 (94.8%)	1
Gradual	2 (4.3%)	4 (7.6%)	0.68	4 (6.5%)	4 (5.2%)	1
Course of tinnitus						
Progressive	19 (41.3%)	17 (32.69%)	0.408	25 (40.3%)	27 (35.06%)	0.598
Static	27 (58.6%)	35 (67.3%)	0.408	36 (58.06%)	49 (63.6%)	0.6
fluctuating	0	1	-	1	1	1
Nature of tinnitus						
Continuous	41 (89.1%)	46 (88.4 %)	1	58 (93.5%)	68 (88.3%)	0.385
Intermittent	5 (10.8%)	5 (9.6%)	1	4 (6.4%)	8 (10.4%)	0.548
Pulsating	0	1	-	0	1	1

G1=group 1(Normal hearing with tinnitus group), G2=group 2 (Hearing loss with tinnitus group).

Table 3. Comparison of right and left tinnitus ears of normal hearing and hearing loss with tinnitus subjects.

Clinical characteristics	G1 Right ear, N=46	G2 Right ear, N=62	Z test of proportionality (P value)	G1 Left ear, N=52	G2 Left ear, N=77	Z test of proportionality (P value)
Duration of tinnitus						
<3 months	9 (19.5%)	10 (16.1%)	0.646	12 (23.07%)	16 (20.77%)	0.758
3-6 months	11 (23.9%)	11 (17.7%)	0.437	6 (11.53%)	17 (22.07%)	0.104
6 months-1 year	11 (23.9%)	7 (11.2%)	0.091	12 (23.07%)	12 (15.5%)	0.295
1-2 years	7 (15.2%)	17 (27.4%)	0.116	10 (19.23%)	15 (19.48%)	0.972
2-3 years	1 (2.1%)	4 (6.4%)	0.259	3 (5.76%)	6 (7.7%)	0.647
>3 years	7 (15.2%)	13 (20.9%)	0.617	9 (17.3%)	11 (14.28%)	0.805
Onset of tinnitus						
Sudden	44 (95.6%)	58 (93.5%)	0.627	48 (92.3%)	73 (94.8%)	0.577
gradual	2 (4.34%)	4 (6.4%)	0.627	4 (7.69%)	4 (5.19%)	0.577
Course of tinnitus						
Progressive	19 (41.3%)	25 (40.3%)	0.918	17 (32.6 %)	27 (35.06%)	0.78
Static	27 (58.6%)	36 (58.06%)	0.948	35 (67.3%)	49 (63.63%)	0.666
fluctuating	0	1	-	-	1	-
Nature of tinnitus						
Continuous	41 (89.1%)	58 (93.5%)	0.426	46 (88.4%)	68 (88.31%)	0.979
Intermittent	5 (10.8%)	4 (6.4%)	0.426	5 (9.61%)	8 (10.3%)	0.885
Pulsating	0	0	-	1	1	-

G1=group 1(Normal hearing with tinnitus group), G2=group 2 (Hearing loss with tinnitus group).

Table 4. Comparison of gender differences between normal hearing with tinnitus and hearing loss with tinnitus group.

Clinical characteristics	Group-G1 T_M (N=56)	T_F (N=42)	Z test of proportionality (P value), T_M *vs*. T_F	Group-G2 T_M1 (N=103)	T_F1 (N=36)	Z test of proportionality (P value), T_M1 *vs*.T_F1
Duration of tinnitus						
<3 months	16 (28.5%)	5 (11.9%)	0.03	23 (22.3%)	3 (8.33%)	0.023
3-6 months	7 (12.5%)	10 (23.8%)	0.153	21 (20.38%)	7 (19.4%)	1
6 months-1 year	13 (23.2%)	10 (23.8%)	0.945	12 (11.65%)	7 (19.4%)	0.287
1-2 years	13 (23.2%)	4 (9.52%)	0.058	23 (22.33%)	9 (25%)	0.748
2-3 years	4 (7.14%)	0		6 (5.82%)	4 (11.11%)	0.356
>3 years	3 (5.35%)	13 (30.95%)	0.001	18 (17.47%)	6 (16.66%)	0.911
Onset of tinnitus						
Sudden	53 (94.6%)	40 (95.2%)	0.894	99 (96.11%)	31 (86.11%)	0.09
gradual	3 (5.35%)	2 (4.76%)	0.894	4 (3.88%)	5 (13.88%)	0.09
Course of tinnitus						
Progressive	14 (25%)	21 (50%)	0.01	35 (33.98%)	16 (44.44%)	0.271
Static	42 (75%)	20 (47.6%)	0.004	66 (64.07%)	20 (55.55%)	0.371
fluctuating	0	1		2 (1.94%)	0	
Nature of tinnitus						
Continuous	48 (85.71%)	39 (92.85%)	0.244	94 (91.26%)	32 (88.88%)	0.689
Intermittent	8 (14.28%)	2 (4.76%)	0.096	8 (7.76%)	4 (11.11%)	0.569
Pulsating	1	0		1 (0.97%)	0	

T_M=Total male group 1,T_F=Total female group 1, T_M1=Total male group 2, T_F1=Total female group 2, G1=group 1(Normal hearing with tinnitus group), G2=group2 (Hearing loss with tinnitus).

Results revealed that significantly more ($p<0.03$ and $p<0.023$) number of males in both G1 and G2 group (28.3% and 22.3% respectively) reported earlier than females (11.9% and 8.3% respectively) within a duration of 3 months. Additionally significantly large ($p<0.001$) number of females in the normal hearing with tinnitus group reported after a time span of 3 years.

Furthermore, significantly large number of males and females in both normal hearing and hearing loss with tinnitus group reported with sudden onset of tinnitus. Also, a significant number ($p<0.004$) of males in G1 reported course of tinnitus as static, whereas a significant number of females ($p<0.01$) as progressive. The nature of tinnitus showed no statistically significant difference in normal hearing males and females.

Inter group gender comparisons

The differences between males of G1 and G2

Table 5. Comparison of male as well as females of the normal hearing with tinnitus versus hearing loss with tinnitus group.

Clinical characteristics	Male G1 *vs.* G2			Female (G1 *vs.* G2)			Combined		
	G1	G2	Z test	G1	G2	Z test	G1	G2	Z test of proportionality
	T_M (N=56)	T_M1 (N=103)	P value (T_M *vs.* T_M1)	T_F (N=42)	T_F1 (N=36)	P value (T_F *vs.* T_F1)	Total G1 (N=98)	Total G2 (N=139)	P value (G1 *vs.* G2)
Duration of tinnitus									
<3 months	16 (28.57%)	23 (22.33%)	0.393	5 (11.90%)	3 (8.33%)	0.599	21 (21.42%)	26 (18.70%)	0.608
3-6 months	7 (12.5%)	21 (20.38%)	0.184	10 (23.8%)	7 (19.44%)	0.639	17 (17.34%)	28 (20.14%)	0.585
6 months-1 year	13 (23.21%)	12 (11.65%)	0.074	10 (23.8%)	7 (19.44%)	0.639	23 (23.46%)	19 (13.66%)	0.058
1-2 years	13 (23.21%)	23 (22.33%)	0.899	4 (9.52%)	9 (25%)	0.069	17 (17.34%)	32 (23.02%)	0.278
2-3 years	4 (7.14%)	6 (5.82%)	0.75	0	4 (11.11%)	0.034	4 (4.08%)	10 (7.19%)	0.294
>3 years	3 (5.35%)	18 (17.47%)	0.012	13 (30.95%)	6 (16.6%)	0.131	16 (16.32%)	24 (17.26%)	0.849
Onset of tinnitus									
Sudden	53 (94.64%)	99 (96.11%)	0.679	40 (95.23%)	31 (86.11%)	0.169	93 (94.89%)	131 (94.24%)	0.826
Gradual	3 (5.35%)	4 (3.88%)	0.679	2 (4.76%)	5 (13.88%)	0.169	5 (5.10%)	8 (5.75%)	0.826
Course of tinnitus									
Progressive	14 (25%)	35 (33.98%)	0.227	21 (50%)	16 (44.44%)	0.624	36 (36.73%)	52 (37.41%)	0.916
Static	42 (75%)	66 (64.07%)	0.144	20 (47.61%)	20 (55.55%)	0.483	62 (63.26%)	84 (60.43%)	0.658
Fluctuating	0	2 (1.94%)		1 (2.38%)	0		1	2 (1.43%)	
Nature of tinnitus									
Continuous	48 (85.71%)	94 (91.26%)	0.308	39 (92.85%)	32 (88.88%)	0.546	87 (88.77%)	126 (90.64%)	0.643
Intermittent	8 (14.28%)	8 (7.76%)	0.225	2 (4.76%)	4 (11.11%)	0.304	10 (10.20%)	12 (8.63%)	0.685
Pulsating	1 (1.78%)	1 (0.97%)		0	0		1 (1.02%)	1 (0.71%)	0.809

T_M=Total male group 1, T_F=total female group 1, T_M1=Total male group 2, T_F1=Total female group 2, G1=group 1 (Normal hearing with tinnitus group), G2=group 2 (Hearing loss with tinnitus).

and females of G1 and G2 groups revealed statistically significant difference only for "greater than three years duration". A significantly large number of males ($p<0.012$) in the G2 group, reported after 3 years of onset of tinnitus, whereas, majority of males in G1 group reported within 3 months post onset (Table 5).

Additionally, on summing up the number of males reporting within a time span of less 1 year, (64.28% in G1 and 54.36% in G2), and between 1 to 3 years' time (35.7 % in G1 and 45.62% in G2), it became evident that males of the G1 group reported earlier than G2. Furthermore, a similar trend was also observed in females; 59.5% in G1 and 47.21% in G2 reported within 1 year, while 40.47% in G1 and 52.71% in G2 reported between 1 to 2 years' time span.

The results thus highlighted that normal hearing with tinnitus group reported earlier than hearing loss with tinnitus group. Significantly large number of subjects (94.8% and 98.2% respectively) in both groups reported with sudden onset of tinnitus.

It was also observed that tinnitus was largely reported as static, by males of both G1 and G2, whereas proportionately equivalent number of females in both groups described it to be static as well as progressive (47.6% as static and 50% as progressive in G1, 44.4% as static and 55.5% as progressive in G2). Both the groups had a predominantly continuous form of tinnitus.

DISCUSSION

The results of the present study observed a greater number of males with tinnitus in both normal hearing and hearing loss with tinnitus groups (56% and 77% respectively). However, we came across only one study reporting significant predominance of males (61.4% males *vs.* 38.6% of females) especially in hearing loss with tinnitus subjects, whereas slight predominance of females in normal hearing with tinnitus group (52.2% females *vs.* 47.8% males) was also reported in literature[2]. In general, our results seemed to confirm the findings of literature that frequency of men reporting with tinnitus is more than females[2]. Increasing risk of tinnitus in men could be due to an association of greater professional and leisure noise in males[15].

The results of the present study also showed preponderance towards the left ear tinnitus irrespective of hearing status. These results are in agreement with many researchers[16-19]. The most striking finding of this data was that irrespective of the hearing thresholds (normal hearing/hearing loss), gender variation, the tinnitus laterality was more prevalent towards the left side. The possible explanation for our results could be that there is a

biological effectiveness of right efferent auditory pathway as compared to the left pathway[20]. However, there is controversy in the literature about the most common side of tinnitus. Some researchers have reported right ear tinnitus predominance for the normal hearing group and left ear tinnitus predominance for hearing loss group[21]. One possible reason for this discrepancy, could be that in present study we merged the right and left tinnitus ears of bilateral tinnitus subjects into right and left unilateral tinnitus subjects for purpose of statistical analysis.

Another intriguing finding of current study was that among the hearing loss group, left ear hearing loss with tinnitus group (58.34% within 1 year) reported earlier as compared to right ear hearing loss with tinnitus group (45% within 1 year), whereas such a trend was not observed in normal hearing with tinnitus group (67.3% right ear tinnitus and 57.54% left ear tinnitus reported within 1 year). We believe that the left hearing loss with tinnitus is more disturbing. Furthermore, literature has also associated left-sided hearing loss with tinnitus and depressed mood, which further supports our findings[22,23].

Also, the normal hearing with tinnitus group reported earlier than the hearing loss with tinnitus group, emphasizing that the phantom (tinnitus) is more disturbing in subjects with normal hearing than with hearing loss. This datum disagrees with the findings of previous researchers that hearing loss with tinnitus subjects has increased disturbance than normal hearing with tinnitus subjects[13]. Our findings could indicate that, in hearing loss with tinnitus subjects, tinnitus might only be audible only in very calm surroundings due to co-existing hearing loss, and not disturbing during routine activities[13]. Hence, the normal hearing with tinnitus subjects were more disturbed than hearing loss with tinnitus group and reported earlier.

In both the tinnitus groups, males reported with tinnitus within three to six months of onset, whereas most of the females in the normal hearing with tinnitus group reported after a span of three years and in hearing loss with tinnitus group after 2 years. Our findings were atypical, against the common belief that women are more exasperated with tinnitus and observed stress far more than men did[24]. These findings were somewhat paradoxical. It can however be hypothesized, that various intrinsic factors (social, political, cultural and economic) act as major contributors towards gender variability in reporting time after tinnitus, particularly in India context.

A large number of subjects reported with sudden onset of tinnitus especially in left ear. Few studies in literature have also reported sudden onset of tinnitus, which was whistling type and stable over time[21,25]. Tinnitus however remained static in males and showed progression of loudness, in substantially large number of females. It can be hypothesized from these results that enhanced emotional responses to tinnitus by females could lead to progression in tinnitus loudness.

CONCLUSION

Although still modest, more and more attention is being directed towards clinical features of tinnitus subjects. In the present study, our results revealed a greater preponderance of left ear tinnitus. The tinnitus was more disturbing in normal hearing with tinnitus group. Furthermore, significant number of males reported with tinnitus. In addition, this study proposes a relationship between progressions of tinnitus in females to greater emotional distress.

This study highlights the importance of taking a detailed case history, in-depth evaluation of features of tinnitus in normal hearing and hearing loss subjects, which could provide an insight into selecting an appropriate therapeutic technique for tinnitus subjects.

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