

## Multivariate Analysis of the Factors Affecting Tinnitus Severity in Old Age: A Multi-Center Cross-Sectional Study

Yaşlılarda Tinnitus Şiddetini Etkileyen Faktörlerin Çok Değişkenli Analizi: Çok Merkezli Çalışma

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### ABSTRACT

**Aim:** The purpose of this study was to analyze the factors affecting tinnitus severity in the population aged 60 and over with a multi-central data and with multivariate analysis.

**Materials:** This prospective study was composed of 130 subjects aged 60 years or older with clinical complaint of tinnitus and administered to five different otorhinolaryngology clinics in four different cities in our country. All participants have been tested with pure tone audiometry. Tinnitus loudness and pitch mapping were determined for all participants. All participants also interviewed individually to complete Tinnitus Handicap Inventory (THI) and asked to characterize their tinnitus symptoms using a visual analog scale (VAS) measuring severity, annoyance of tinnitus.

**Results:** Tinnitus loudness increases significantly in the group over the age of 79, but there is no significant difference between the groups formed according to age in terms of VAS or THI values. Systemic disease does not make a significant difference that increases the severity of tinnitus. risk factors that increase tinnitus severity are included in the logistic regression analysis; High level of education and advanced age over 79 years were determined as independent risk factors. Increasing education level is an independent risk factor for increasing tinnitus severity with an odds ratio of 2.46 (95% CI, 1.080-5.624). At the same time, advanced age over 79 years is an independent risk factor with an odds ratio of 5.4 (95% CI, 1.385-21.197), which causes tinnitus severity to be felt more.

**Conclusion:** In old age population, the incidence of tinnitus does not increase with increasing age, but tinnitus severity increases. As hearing loss increases, tinnitus severity and VAS score increase. According to the results of this study, the most important risk factors that increase the perception of tinnitus in the elderly population were determined as very advanced age and high education level. It is reasonable to think that one of the reasons for this is that the elderly in the vulnerable group for the Covid 19 pandemic should stay away from hospitals unless their tinnitus complaints are very serious. Re-performing our study in elderly individuals after the pandemic is important to see the effect of the pandemic period more clearly in these individuals.

**Keywords:** Tinnitus, aged, multi-center

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### ÖZET

**Amaç:** Çalışmanın amacı, yaşlı popülasyonda tinnitus şiddetini etkileyen faktörleri çok merkezli veriler ve çok değişkenli analizlerle incelemektir.

**Gereç:** Bu prospektif çalışma, klinik olarak tinnitus şikayeti olan ve dört farklı ilde beş farklı kulak burun boğaz kliniğine başvuran 60 yaş ve üzeri 130 kişiden oluşturuldu. Saf ses odyometrisi ile test edilen tüm katılımcılar; kulak çınlaması şiddeti ve perde uyumu belirlendi. Tinnitus Handicap Envanteri (THI) ve tinnitus şiddetini, rahatsızlığını ölçen bir görsel analog skala (VAS) kullanıldı.

**Bulgular:** Yaşa göre oluşturulan gruplar arasında VAS veya THI değerleri açısından anlamlı bir fark bulunmamıştır. Ancak tinnitus şiddeti 79 yaş üstü grupta diğer yaş gruplarına göre anlamlı olarak daha yüksek değerlerde elde edilmiştir. Tinnitus şiddeti üzerinde sistemik hastalık varlığının etkisi saptanamamış olsa da; yüksek eğitim düzeyi ve 79 yaş üzeri ileri yaş varlığı bağımsız risk faktörleri olarak belirlendi. Tinnitus şiddetinin daha fazla hissedilmesinde, artan eğitim düzeyinin 2,46 (%95 GA, 1.080-5.624), 79 yaş ve üzerinde olmanın 5,4 (%95 CI, 1.385-21.197) olasılık oranıyla, bağımsız birer risk faktörü oldukları anlaşılmıştır.

**Sonuç:** Yaşlı popülasyonda yaş arttıkça tinnitus insidansında artış gözlenmezken, tinnitus şiddeti artmaktadır. İşitme kaybı arttıkça tinnitus şiddeti ve VAS skoru artar. Yaşlı popülasyonda tinnitus şiddetini artıran en önemli risk faktörleri çok ileri yaş ve yüksek eğitim düzeyi olarak belirlendi. Bunun nedenlerinden birinin de Covid 19 pandemisi karşısında savunmasız gruptaki yaşlıların kulak çınlaması şikayetleri çok ciddi olmadıkça hastanelerden uzak durmaları gerektiğini düşünmek mantıklıdır. Pandemi sonrası yaşlı bireylerde çalışmamızın yeniden yapılması, bu bireylerde pandemi döneminin etkisini daha net görebilmek açısından önemlidir.

**Anahtar Sözcükler:** Tinnitus, yaşlı, multi-center

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## INTRODUCTION

Tinnitus is a condition in which patients perceive some sounds in the absence of external acoustic stimuli (1). The incidence of tinnitus is between 10 and 26% in adults and it is estimated that this rate increases with age. Incidence of tinnitus was reported as 36% in the elder subjects (85 years of age<) who applied to clinics with hearing loss. (2, 3, 4, 5). Although association of aging with hearing loss could be clearly observed, no apparent association was evident between aging and tinnitus. The relationship of aging with tinnitus is still debate.

Tinnitus has a negative impact in their life of the suffers in terms of functional and emotional aspects. Many factors are defined for increasing complaint of tinnitus such as age, gender, smoking, stress, sleep, hearing loss, hyperlipidemia, hypertension, depression, and thyroid disease (4,12,13,14). Some studies report that age is especially effective in increasing the degree of tinnitus. (6, 4). Similarly, it is stated that tinnitus is a significant risk factor for depression, especially in elderly men (9). However, there are studies that claim the opposite. A study investigating the age-related tinnitus attitude states the opposite of this situation. Accordingly, it has been understood that as age increases, it is easier to adapt to living with tinnitus. At the same time, there was no difference in tinnitus degree, anxiety and depression scores between the young and elderly population (8).

It is controversial to what extent the low quality of life and depression scores in these individuals can be associated with tinnitus, regardless of the complaints of elderly individuals about their deteriorating health status with age. Elderly persons generally sleep less, have more systemic diseases, and are more alone in their daily lives (8,12,16). These reasons may cause tinnitus to be felt more (3,16). Whether insomnia is secondary to tinnitus or tinnitus is the result of a long sleepless state remains unclear. Khedr et al (3) said that sleep disturbance was reported by 39.4% of tinnitus subjects and life enjoyment was severely affected in 15% of tinnitus patients. Kim et al. (4) said that annoying tinnitus increased with stress and some systemic diseases such as hyperlipidemia. However, Chang et al (13) detected that tinnitus was not associated with age, Body Mass Index, hypertension, diabetes but was associated with hearing impairment.

The feeling of discomfort caused by tinnitus is usually evaluated with scales such as visual analog scale, tinnitus handicap inventory and depression scales (15). In many studies, there was no certain relationship found between no relationship was detected between these scale and tinnitus physco-acoustic measurement values (tinnitus frequency, loudness etc.) or tinnitus exposure time (10,11). In this context, it is not fully understood whether the degree of tinnitus that affects the person increases with age and which factors increase especially in the elderly group.

Population based studies from different countries have not reached a consensus on the relationship between tinnitus and aging process, and the factors that increase the severity of tinnitus. The purpose of this study was to analyze the factors affecting the degree of tinnitus in the population aged 60 and over by using multivariate analysis.

## MATERIAL and METHODS

## Study Design and data collection

This study was approved by University Institutional Review Board and Ethics Committee (Project no: KA19/174) and supported by University Research Fund. It was carried out in accordance with the principles of the Helsinki Declaration between May 2020 and May 2021. The study centers were Department of Otorhinolaryngology and Head Neck Surgery (ORL-HNS) in Baskent University Faculty of Medicine (FM), Adana Research and Training Hospital, Department of ORL-HNS-Audiology in Gazi University FM, Department of ORL-HNS-Audiology in Dışkapı Yıldırım Beyazıt Training and Research Hospital (TRH), Department of Audiology in Kayseri TRH, University of Health Sciences, Department of Audiology, and ORL-HNS in Inonu University Faculty of Medicine. A written informed consent was obtained from all subjects.

This prospective and cross-sectional study was composed of 130 subjects who were 60 years of age or older, who were suffering from tinnitus clinically.

The inclusion criteria were as follows: the subjects with a chronic tinnitus (more than 6 months), who were older than 60 years of age.

The exclusion criteria were as follows: the subjects with history of dementia or other cognitive problems that prevent the audiological test, those with psychiatric diseases that could affect their quality of life and the subjects who answered the questionnaires incompletely.

The following data were also asked to all subjects: educational status, history of smoking, coffee and alcohol consumption, noise exposure history, systemic disease like hypertension, hypercholesterolemia, diabetes mellitus, and cardiovascular disease.

Table 1: Demographic Analysis of Patients

Age Group	n	%
60-69	50	38.5
70-79	59	45.4
>79	18	13.8
<b>Gender</b>		
Men	65	50.0
Female	65	50.0
<b>Education</b>		
Low	81	62.3
High	49	37.7
<b>Jop</b>		
yes	65	50.0
no	65	50.0
<b>Hearing Loss</b>		
no	41	31.5
bilateral	34	26.2
unilateral	55	42.3
<b>Duration of hearing loss</b>		
no	41	31.5
6 mo-1 year	24	18.5
2- 4 years	59	45.3
>4 years	6	4.7
<b>Tinnitus Time</b>		
6 month- 1 year	62	47.7
1-3 years	20	15.4
>3 years	48	36.9
<b>Noise Exposure</b>		
yes	107	82.3
no	23	17.7
<b>Is the tinnitus continuous?</b>		
No	19	14.6
Only in quiet environments	22	16.9
Continously	89	68.5
<b>tinnitus type</b>		
no information	47	36.2
uncertain	2	1.5
pulsatile	23	17.7
pure tone	56	50.1
warble	2	1.5

## Audiological Evaluation

All participants were tested with pure tone audiometry (Interacoustics-AC-40®, Denmark) and speech audiometry in a quiet cabin with the standard of Industrial Acoustic Company (IAC). As a rule, the mean threshold of speech frequencies (0.5-4 kHz) between 0-15 dB, and the speech discrimination score of 92% and above were accepted normal. For all participants, the pure-tone average was separately evaluated as the mean for three speech frequencies (0.5, 1, and 2 kHz) and high frequencies (4, 6, 8 kHz) for left and right sides to analyze the correlation of age-related hearing loss.

*Tinnitus Evaluation with tinnitus mapping;*

Tinnitus loudness and pitch mapping were determined for all participants (17). For unilateral tinnitus, the ear with tinnitus was chosen as the test ear. For bilateral tinnitus, the right ear was chosen when equal tinnitus loudness was present; the ear with the loudest tinnitus was chosen in case of unequal tinnitus loudness.

It was determined by asking the patient to choose the one that most closely resembles his/her tinnitus among 2 different frequency signals, starting from the frequency value of 1000 Hz. In patients with unilateral tinnitus, the measurement of tinnitus frequency was performed from the contralateral ear. In cases where tinnitus was bilateral, tinnitus matching measurement was made from the ipsilateral ear. Evaluation from the ear, where the patient stated the tinnitus severity as less; If the tinnitus is the same in both ears, it is made in the ear with less hearing loss. Test frequencies are 125, 250, 500, 1000, 2000, 4000, 6000 and 8000 Hz.

*Evaluation of tinnitus severity with VAS and THI;*

All patients were asked to characterize their tinnitus symptoms using a visual analog scale (VAS) measuring severity, annoyance of tinnitus. VAS most commonly consists of a line on a sheet of paper with numbers from "0" to "10". The individual is asked to mark the level of perception regarding the severity of tinnitus and the degree of discomfort. "0" represents the lowest and "10" the highest level of perception.

All participants also interviewed individually to complete Tinnitus Handicap Inventory (THI) to determine awareness of tinnitus and its effect on life (19,20)-THI contains 25 questions with a point scale based on answers of yes (4 points), sometimes (2), and no (0). The total score (0–100 point range) is classified into four categories: 0–16, no handicap; 18–36, mild handicap; 38–56, moderate handicap; and 58–100, severe handicap.

*Statistical Analysis;*

All statistical analyses were performed using SPSS version 25.0, with p-values < 0.05 considered statistically significant.

Expression of data was performed as median and range for continuous variables and as frequency and percentage for categorical variables. The participants were divided into 3 groups according to age; group 1 (60-69 years old), group 2 (70-79 years old), group 3 (80 years old and older) to determine the difference of tinnitus perception and mapping regarding to age using ANOVA test. The participants were divided into 2 subgroups regarding hearing loss (those with and without hearing loss). Then, tinnitus perception and loudness were compared between these two subgroups.

Multivariate binary logistic regression analyses were used to analyze the relationship between tinnitus development and increase of severity and risk factors regarding all participants.

According to normality of the values, Spearman or Pearson correlation analysis was used to correlate VAS and THI with loudness of tinnitus.

**RESULTS***Univariate Analysis*

A total of 130 participants who underwent the hearing tests and completed the questionnaire were included. There were 65 were male (50%) and 65 were female (50%) subjects. The ages ranged from 60 to 84 years of age (mean= 70,3; median=71 years).

Tinnitus loudness increases significantly in the group over the age of 79, but there was no significant difference between the groups formed according to age in terms of VAS or THI values. Systemic disease did not make a significant difference in the severity of tinnitus (Table 1).

When the participants were classified as having hearing loss or not; The mean age was found to be significantly higher in the group with hearing loss. In addition, while tinnitus loudness was found to be higher in this group, the THI ratio was lower (Table 2).

**Table 2:** Univariate Analysis of Risk Factors

	Tinnitus Frequency (Hz)		Tinnitus Loudness(dB)		VAS	
	Mean±SD	Med (Min-Max)	Mean±SD	Med (Min-Max)	Mean±SD	Med (Min-Max)
<b>Age Group</b>						
60-69	4729,6±2166,9	4000(125-9000)	61,0±14,7	60(30-95)	6,2±1,8	6(2-10)
70-79	4927,9±2877,1	4000(125-12500)	63,4±17,1	60(25-100)	6,0±1,5	6(3-9)
>79	4986,1±3525,6	5000(250-12500)	74,3±24,4	77(24-110)	6,3±1,8	6(3-9)
<b>p</b>	<b>0,912</b>		<b>0,024</b>		<b>0,765</b>	
<b>Gender</b>						
Male	4931,6±2565,9	4000(125-12500)	65,3±18,3	63(30-110)	6,1±1,8	6(2-10)
Female	4764,1±2881,9	4275(125-12500)	63,2±17,4	65(24-100)	6,1±1,6	6(3-9)
<b>p</b>	<b>0,729</b>		<b>0,500</b>		<b>0,916</b>	
<b>Hypertension</b>						
Yes	4590,3±2460,4	4000(125-9000)	65,7±18,9	70(25-102)	6,2±1,7	6(3-10)
No	5024,0±2885,4	4275(125-12500)	63,2±16,9	61(24-110)	6,1±1,6	6(2-10)
<b>p</b>	<b>0,378</b>		<b>0,436</b>		<b>0,859</b>	
<b>Diabetes Mellitus</b>						
Yes	4571,9±2675,4	4275(125-9000)	62,2±18,7	60(30-95)	6,1±1,8	6(3-9)
No	4911,5±2737,8	4000(125-12500)	64,7±17,6	65(24-110)	6,1±1,6	6(2-10)
<b>p</b>	<b>0,583</b>		<b>0,537</b>		<b>0,951</b>	
<b>Hearing Loss (dBHL)(right)</b>						
<56	4932,9±2815,8	4000(125-12500)	63,6±17,9	62(24-110)	6,1±1,6	6(2-10)
>56	4206,7±1771,8	4000(500-8000)	68,9±16,8	65(48-100)	6,3±1,8	6(3-9)
<b>p</b>	<b>0,333</b>		<b>0,297</b>		<b>0,752</b>	
<b>Hearing Loss (dBHL)(left)</b>						
<56	4974,1±2777,2	4275(125-12500)	64,2±17,9	65(24-110)	6,2±1,7	6(2-10)
>56	3627,1±1712,2	4000(125-6500)	64,8±17,7	61(45-100)	5,8±1,5	6(3-9)
<b>p</b>	<b>0,103</b>		<b>0,903</b>		<b>0,506</b>	

When the tinnitus frequency is above 4000 Hz and those below 4000 Hz are compared; tinnitus loudness value and VAS score were found to be significantly higher in the group above 4000 Hz(Table 3).

**Table 3:** Severity of Tinnitus According to Frequency

Tinnitus Frequency (Hz)	Tinnitus Frequency (dB)		VAS	
	Mean±SD	Med (Min-Max)	Mean±SD	Med (Min-Max)
4000 and below	60,9±18,7	60(24-110)	5,8±1,8	5 (2-10)
>4000	68,1±16,0	70(30-102)	6,4±1,4	6 (3-9)
<b>p</b>	<b>0,023</b>		<b>0,043</b>	

A correlation was detected between tinnitus loudness and VAS. However, there was no correlation between VAS and THI (Table 4).

**Table 4:** Correlations Between THI and VAS, Tinnitus Frequency and Loudness.

		THI	Tinnitus Frequency (Hz)	Tinnitus Loudness(dB)
Tinnitus Frequency (Hz)	r	0,13	-	-
	p	0,135	-	-
Tinnitus Loudness(dB)	r	0,11	0,34*	-
	p	0,226	0,0001	-
VAS	r	0,05	0,23*	0,52*
	p	0,568	0,008	0,0001

**Multivariate Analysis**

When all risk factors that increase tinnitus severity are included in the logistic regression analysis; High level of education and advanced age over 79 years were determined as independent risk factors.

Increasing education level is an independent risk factor for increasing tinnitus severity with an odds ratio of 2.47 (95% CI, 1.080-5.624). At the same time, advanced age over 79 years is an independent risk factor with an odds ratio of 5.42 (95% CI, 1.385-21.197), which causes tinnitus severity to be felt more (Table 5).

**Table 5.** Multivariate Analysis of Tinnitus Risk Factors.

	B	S.E.	Wald	df	p	Odds Ratio	95% C.I.for Odds Ratio Lower	Upper
Step 1 <sup>a</sup>								
Gender	,086	,442	,038	1	,845	1,090	,459	2,591
Education	,828	,483	2,941	1	,086	2,290	,888	5,901
Hypertension yes no	,037	,441	,007	1	,934	1,037	,437	2,464
Diabet mellitus yes no	,244	,520	,221	1	,638	1,277	,461	3,534
Coffee Consumption	,259	,507	,261	1	,610	1,295	,480	3,497
Cigarette Consumption	,910	1,496	,370	1	,543	2,485	,132	46,680
THI	-,015	,009	2,809	1	,094	,985	,968	1,003
Tinnitus Frequency(Hz)	,000	,000	9,526	1	,002	1,000	1,000	1,000
Tinnitus Loudness(dB)	,024	,015	2,476	1	,116	1,025	,994	1,056
VAS	,197	,153	1,643	1	,200	1,217	,901	1,644
Age Group			5,103	2	,078			
Group (1)	,809	,463	3,058	1	,080	2,247	,907	5,566
Group(2)	1,431	,748	3,664	1	,056	4,182	,966	18,101
Constant	-1,747	1,159	2,274	1	,132	,174		
Step 8 <sup>a</sup>								
Education	,902	,421	4,596	1	,032	2,465	1,080	5,624
Tinnitus Frequency (Hz)	,000	,000	8,107	1	,004	1,000	1,000	1,000
VAS	,300	,130	5,300	1	,021	1,350	1,046	1,742
Age Group			7,146	2	,028			
Age Group(1)	,834	,438	3,616	1	,057	2,302	,975	5,436
Age Group(2)	1,690	,696	5,896	1	,015	5,419	1,385	21,197
Constant	-1,556	,902	2,973	1	,085	,211		

THI: Tinnitus Handicap Inventory, VAS: Visual Analog Scale

**DISCUSSION**

In this study, we analyzed the factors that increase the degree of tinnitus in patients presenting with tinnitus in the advanced age group of 5 clinics in 4 different cities. We found that the presence of hearing loss, very advanced age and tinnitus frequency higher than 4000 Hz were statistically significant factors

in univariate analysis. With logistic regression analysis, we found that very advanced age (>79 years) and high education level are independent risk factors for feeling tinnitus more severely.

Pinto et al. (21) did not find any significant relationship between gender, age and hearing loss and tinnitus annoyance using the THI in a single-center study on 68 patients.

Our study also did not show the significant effect of gender on severity of tinnitus. However, our study showed that very advanced age and hearing loss is important for perception of tinnitus.

Hearing impairment has been reported as a risk factor related to persistent tinnitus in previous studies (22,23). Chang et al. (13) claimed that hearing loss may not be a good predictor for tinnitus. Although they found that hearing loss was a major risk factor for tinnitus, they detected low sensitivity and specificity of hearing loss for producing tinnitus risk (13). In our study, hearing loss is determined as a risk factor for tinnitus annoyance in univariate analysis; however, logistic regression analysis showed that hearing loss is not an independent risk factor. This finding is compatible with result of Chang et al.

Osterloo et al (6) determined the prevalence of tinnitus as %21.4 in population older than 50 year old and similar prevalence of tinnitus over the age groups. Our study could not give the prevalence in general population. However, our study could detect the high risk of advanced old age (>79 year old) for tinnitus severity. Osterloo et al (6) found that 1 out of 10 persons with tinnitus interfered with their daily life due to the tinnitus and claimed that aging however does not put individuals at greater risk of developing tinnitus. Our study showed that advanced age group has least number of participants and has higher loudness of tinnitus. However this group did not showed significant high score in VAS and THI. In this regard, we could claim that tinnitus has not interfered daily life in advanced age.

The education level was determined as an insignificant factor for tinnitus in the study of Osterloo et al (6). However, we found that higher education level is an independent risk factor for severity of tinnitus in old age. The education level may cause awareness and can create the thought that there is an important disease. The education level also may provide the intelligibility of the questionnaires such as THI and the perception of tinnitus.

In this study, there was no correlation between VAS and THI. The Visual Analogue Scale (VAS) is a popular tool for the measurement of pain. A variety of statistical methods are employed for its analysis as an outcome measure (18). Mantello et al (10) also found weak correlation between VAS and THI. They claimed that VAS is an easier method for their population. Actually, this idea may be also valid for old age patients. The THI is a complete method of assessment, especially concerning the psychological and everyday aspects of tinnitus (10,15,20). Using the two methods together in clinical trials of tinnitus annoyance makes the results more reliable.

This study has some limitations. Especially insufficient number of participants is the major limitation. However, the period when the study was conducted was the early stages of the Covid 19 disease and the elderly population was hesitant to apply to hospitals because the vaccination rates were not sufficient in the community. Obviously, this situation can show us that; the decrease in the number of applications due to subjective tinnitus does not reach a degree that limits daily activities in every patient with this disease. Of course, this speculation can be proven by comparing the tinnitus rates before and during the Covid 19 disease and after vaccination. The other limitation factor was not being questioned for depression. Geocze et al (24) and Young et al (11) showed that there is a high prevalence of depressive symptoms in individuals with tinnitus.

## CONCLUSION

In old age population, the incidence of tinnitus does not increase with increasing age, but tinnitus severity increases. As hearing loss increases, tinnitus severity and VAS score increase. According to the results of this study, the most important risk factors that increase the perception of tinnitus in the elderly population were determined as very advanced age and high education level.

It is reasonable to think that one of the reasons for this is that the elderly in the vulnerable group for the Covid 19 pandemic should stay away from hospitals unless their tinnitus complaints are very serious. Re-performing our study in elderly individuals after the pandemic is important to reveal the effect of the pandemic period in these individuals more clearly.

## Conflict of interest

No conflict of interest was declared by the authors.

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