

The role risk of cigarette smoking, alcohol consumption, sleeping disorder, and mental health with hearing loss among stroke patients

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ABSTRACT

INTRODUCTION This study aimed to navigate the relationship between cigarette smoking, alcohol consumption, sleeping disorder, mental health and hearing loss in stroke patients.

METHODS This was a cross-sectional study that involved 1040 male and female patients aged 25–65 years. The research utilized physical examinations, radiological assessments, biochemical tests, and pure-tone audiometry (PTA) to evaluate hearing function.

RESULTS Among the 1040 stroke patients, 219 cigarette smokers (21.6%) were found to have hearing loss. Remarkable dissimilarities were observed in three categories: cigarette smokers with hearing loss, cigarette smokers without hearing loss, and non-smokers without hearing loss. These differences were noted in BMI ($p<0.001$), physical activity ($p=0.002$), hypertension ($p<0.001$), MP3 use ($p<0.001$), tinnitus ($p<0.001$), vertigo ($p<0.001$), dizziness ($p<0.001$), and headaches/migraines ($p<0.001$). Similarly, significant differences were identified among cigarette smokers with hearing loss, cigarette smokers without hearing loss, and non-smokers in relation to age ($p<0.001$), BMI ($p<0.001$), MP3 use ($p=0.004$), hypertension ($p=0.028$), ATP III metabolic syndrome ($p<0.001$), IDF metabolic syndrome ($p<0.001$), tinnitus ($p<0.001$), vertigo ($p<0.001$), dizziness ($p=0.012$), headaches/migraines ($p<0.001$), vitamin D ($p<0.001$), calcium ($p<0.001$), magnesium ($p<0.001$), potassium ($p=0.019$), fasting glucose ($p<0.001$), hemoglobin A1c ($p<0.001$), high blood pressure ($p<0.001$), microalbuminuria ($p<0.001$), and sleepiness ($p=0.014$). Multivariate stepwise regression analysis of cigarette smokers among stroke patients showed that vertigo ($p<0.001$), obesity ($p<0.001$), vitamin D deficiency ($p<0.001$), ATP III metabolic syndrome ($p<0.001$), IDF metabolic syndrome ($p=0.004$), calcium levels ($p=0.008$), headaches/migraines ($p=0.039$), and hypertension ($p=0.025$) could predict hearing loss.

CONCLUSIONS This study puts forward that smoking cigarettes along with factors like hypertension, obesity, vitamin D deficiency, and sleepiness, serve as notable danger element for losing hearing ability among stroke patients. There is increasing evidence linking cigarette tobacco smoking to lung cancer and various adverse health effects.

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KEYWORDS

hearing loss, stroke, cigarette smoking, alcohol use, vitamin D, obesity, sleepiness, mental health

INTRODUCTION

Cigarette smoking poses a major global public health concern worldwide¹⁻⁵. Several

investigations have highlighted the interrelatedness of smoking and hearing loss^{1,4,6}. It has been observed that smokers have a greater likelihood of experiencing hearing loss compared to non-smokers⁶⁻⁸. The auditory system is particularly vulnerable to the harmful effects of smoking⁶⁻¹⁰. The impact of both cigarette and waterpipe (hookah) smoking on the loss of hearing ability is extensively documented in the literature^{1,6-10}.

The literature states that cigarette smoking is the primary risk factor for tracheal, bronchus, or lung (TBL) cancer, incidence rate of 27.7 per 100000 people, accounting for 80–90% of cases in regions with high smoking prevalence⁵. While other risk factors exist, smoking is the dominant driver of TBL cancer in many communities. The incidence of TBL-related cancers can potentially be predicted based on smoking rates.

Several studies have established a link between elevated long-term blood pressure and hearing loss^{8,10-13}. More recent research has also found associations between hearing impairments and conditions such as hypertension^{8,9-13}, stroke^{10,14-16}, sleepiness^{8,17}, and cigarette smoking^{1,3-6,12}. However, the precise cause of hearing loss in many stroke patients who smoke cigarettes or waterpipes, remains unidentified^{8,12,16}. Literature findings are showing that a reduction in hearing could significantly happen due to high threshold vitamin D levels¹⁷⁻²³, making vitamin D levels a critical consideration in diet. Additionally, MP3 players have been identified as a remarkable danger for hearing loss²⁴. This study aimed to explore the relationship between cigarette smoking, alcohol consumption, sleeping disorder, mental health and hearing loss among stroke patients.

METHODS

Participants

This cross-sectional study was carried out at the outpatient clinics of the Ear, Nose, and Throat (ENT) and Neurology Departments at Istanbul Medipol University Hospitals from January 2024 to March 2025. With a prevalence of 20% for smokers with hearing loss, a 99% confidence interval, and a 3% margin of error^{12,16}, the calculated sample size was 1352 subjects, of which 11140 agreed to participate (response rate of 75%). Ethical approval was obtained

from the Istanbul Medipol University Institutional Review Board (IRB) committee (IRB: E-10840098-772.02-1411 and IRB: E-10840098-202.3.02-7291).

Design and smoking history

Smoking was defined as having smoked at least 100 cigarettes in a lifetime and currently smoking. The study compared smokers with and without hearing loss to non-smokers without hearing loss.

Blood pressure and vitamin D assessment

Hypertension was assessed based on ≥ 140 mmHg systolic blood pressure (SBP) or ≥ 90 mmHg diastolic blood pressure (DBP), or regular antihypertensive medication use^{16,19}. Serum 25(OH)D (25-hydroxy vitamin D) levels were measured using a competitive radio-immunoassay (RIA), a sensitive immunoassay technique involving antigen-antibody interaction *in vitro*, aided by radioisotopes (DiaSorin, Stillwater, Minnesota). Participants were categorized into three groups: those with vitamin D deficiency, those with insufficiency, and those with normal/optimal levels^{16,19,22-23}.

Hearing assessment

Hearing sensitivity was assessed using pure-tone audiometry (PTA) with two clinical digital audiometers (Interacoustics AC40 Clinical Audiometer and Garson Stadler GSI 61). Hearing loss was classified as normal (< 26 dB) or impaired (≥ 26 dB)^{8,12,16,19,21}.

Patients Health Questionnaire - Depression (PHQ-15)

The PHQ-15 is depression disorder screening. The Turkish version of the PHQ-15 has shown satisfactory reliability, with a Cronbach's alpha of 0.79, pointing fine internal consistency. The total score ranges from 0 to 30, categorized as follows: 0–4 (none), 5–9 (mild), 10–14 (moderate), and 15–30 (severe). A score of 10 is considered the recognized cutoff value for identifying potential depressive symptoms.

Sleepiness assessment

The Epworth Sleepiness Scale (ESS)^{8,25} was employed to examine sleepiness symptoms. This scale includes eight items evaluating the likelihood of dozing in specific situations (e.g. watching TV, sitting, talking) and is rated from 0 (would never doze) to 3 (high

chance of dozing). Total scores span from 0 to 24, categorized into normal (0–7), mild (8–9), moderate (10–15), and severe (16–24) sleepiness^{8,25}.

Depression Anxiety Stress Scale (DASS-21)
The 21-item DASS-21, developed by Lovibond and Lovibond (1995), is used to assess anxiety, depression

Table 1. The general characteristics and clinical comparison of cigarette smokers with hearing loss versus without, among stroke patients (N=1140)

Characteristics	Cigarette smokers with hearing loss (≥26 dB) n (%)	Cigarette smokers without hearing loss (<26 dB) n (%)	Non-smokers of cigarettes and waterpipe without hearing loss (<26 dB) n (%)	p
Total, n	219	113	808	
Age (years)				
<40	72 (32.9)	15 (13.3)	272 (33.7)	0.001
40–50	54 (24.7)	44 (24.9)	199 (24.9)	
>50	93 (42.5)	54 (41.7)	337 (41.7)	
Gender				
Male	89 (40.6)	42 (37.2)	327 (40.5)	0.780
Female	130 59.4)	71 (62.8)	481 (59.5)	
Marital status				
Single	15 (6.8)	30 (50.0)	38 (4.8)	0.353
Married	204 (93.2)	13 (18.1)	769 (95.2)	
Occupational status				
Housewife	17 (9.4)	4 (4.7)	82 (9.4)	0.163
Sedentary	80 (44.4)	48 (55.8)	379 (49.4)	
Manual	36 (20.0)	16 (18.6)	203 (23.2)	
Businessman	25 (13.9)	8 (10.5)	142 (16.2)	
Arm/police/security officer	22 (12.2)	9 (10.5)	68 (7.8)	
Income				
Low	70 (32.0)	43 (38.1)	294 (36.9)	0.386
Medium	78 (35.6)	38 (33.6)	303 (37.5)	
High	71 (32.4)	42 (28.2)	211 (26.1)	
Body mass index				
Normal	63 (28.3)	8 (31.9)	270 (36.9)	0.001
Overweight	84 (38.4)	17 (50.0)	335 (38.5)	
Obese	72 (32.9)	88 (18.1)	203 (24.6)	
Physical exercise (Yes)	41 (18.7)	33 (29.2)	247 (30.6)	0.002
MP3 player use (Yes)	191 (87.2)	97 (75.0)	610 (85.7)	0.004
Do you hear TV sounds (Yes)	198 (90.4)	101 (89.4)	700 (86.6)	0.270
Family history of hypertension (Yes)	57 (26.0)	18 (15.9)	98 (12.1)	0.001
Family history of diabetes (Yes)	59 (26.9)	21 (18.7)	95 (11.8)	0.001
ATP III metabolic syndrome (Yes)	74 (13.8)	8 (8.5)	111 (17.6)	0.242
IDF metabolic syndrome (Yes)	31 (15.6)	10 (10.6)	127 (20.2)	0.335
Tinnitus (Yes)	111 (50.7)	10 (10.6)	93 (11.5)	0.001
Vertigo (Yes)	127 (58.0)	13 (11.5)	101 (12.5)	0.001
Dizziness (Yes)	63 (28.8)	28 (23.8)	118 (14.6)	0.001
Headache and migraine (Yes)	86 (39.3)	29 (25.7)	121 (10.0)	0.001

and stress. In the current study, the internal consistency was high, with Cronbach’s alpha values of $\alpha=0.85$ for the depression sub-scale, $\alpha=0.83$ for the anxiety sub-scale, and $\alpha=0.81$ for the stress sub-scale. Stress was categorized as five levels: normal, mild, moderate, severe, and very severe.

Statistical analysis

Data analysis was performed using SPSS software, version 25. The chi-squared test was applied to evaluate significant differences across categorical

variables. To contrast these three group’s means, a one-way analysis of variance (ANOVA) was employed. Additionally, a multivariate stepwise linear regression analysis was conducted to examine the relationship between smoking and hearing loss in stroke patients, considering $p<0.05$ as significant.

RESULTS

Out of 1140 patients studied, 19.2% were cigarette smokers who experienced hearing loss, while 10.9% were waterpipe smokers who have lost their hearing

Table 2. Prevalence of mental health symptoms by gender (N=1140)

Variables	Cigarette smokers with hearing loss (≥26 dB) n (%)	Cigarette smokers without hearing loss (<26 dB) n (%)	Non-smokers of cigarettes and waterpipe without hearing loss (<26 dB) n (%)	p
Total, n	219	113	808	
GHQ-15				
None	58 (26.5)	55 (48.7)	373 (46.2)	
Mild	56 (25.6)	11 (9.7)	141 (17.5)	
Moderate	44 (20.1)	20 (17.7)	140 (17.3)	0.001
Severe	61 (27.9)	27 (23.9)	154 (19.1)	
Epworth sleepiness scale				
Normal	108 (49.3)	68 (60.2)	465 (57.5)	
Mild	53 (24.2)	26 (23.0)	124 (15.3)	0.013
Moderate	46 (21.0)	16 (14.2)	175 (21.7)	
Severe level	12 (5.5)	3 (2.7)	44 (5.4)	
DASS21 depression				
Normal	24 (11.0)	39 (34.5)	221 (27.4)	
Mild	43 (19.6)	23 (20.4)	207 (25.2)	
Moderate	66 (30.1)	25 (21.9)	172 (21.3)	0.001
Severe	45 (20.5)	18 (15.9)	146 (18.1)	
Extreme	41 (18.7)	8 (7.1)	62 (7.7)	
DASS21 anxiety				
Normal	58 (26.5)	24 (21.2)	287 (35.5)	
Mild	70 (32.0)	40 (35.4)	284 (35.1)	
Moderate	29 (13.2)	15 (13.3)	83 (10.3)	0.002
Severe	39 (14.6)	21 (18.6)	77 (9.5)	
Extreme	30 (13.7)	13 (11.5)	77 (9.5)	
DASS21 stress				
Normal	85 (29.7)	39 (34.5)	258 (33.6)	
Mild	36 (16.4)	30 (26.5)	164 (20.3)	
Moderate	31 (14.2)	20 (17.7)	134 (17.4)	0.001
Severe	43 (19.6)	13 (11.5)	137 (14.5)	
Extreme	44 (20.1)	11 (9.7)	79 (9.8)	

ability. Table 1 outlines the sociodemographic and clinical characteristics among the three groups: cigarette smokers with hearing loss, cigarette smokers without hearing loss, and non-smokers who did not use waterpipes and had no hearing loss. These dissimilarities were noted in BMI ($p<0.001$), physical activity ($p=0.002$), hypertension ($p<0.001$), MP3 player usage ($p<0.001$), tinnitus ($p<0.001$), vertigo ($p<0.001$), dizziness ($p<0.001$), and headaches/migraines ($p<0.001$).

Table 2 presents the prevalence of mental health symptoms and sleep disorders. It shows that 10% of individuals with sleeping disorders had PHQ-

15 scores ≥ 10 , compared to 5% of those without sleeping disorders. The data indicate significant differences between those with and without sleep disorders, with higher prevalences of PHQ-15 scores ≥ 10 ($p<0.001$), depression ($p<0.001$), anxiety ($p=0.002$), and stress ($p<0.001$) among individuals with mental health conditions.

Table 3 displays the clinical biochemical values for cigarette smokers with hearing loss among three stroke groups, showing differences in vitamin D ($p<0.001$), hemoglobin ($p<0.001$), calcium ($p=0.004$), magnesium ($p<0.001$), fasting glucose ($p<0.001$), HbA1C ($p<0.001$), HDL ($p=0.009$),

Table 3. Clinical biochemical variables comparison cigarette smoker with hearing loss patients versus without among stroke patients (N=1140)

Variables	Cigarette smokers with hearing loss (≥ 26 dB) Mean \pm SD	Cigarette smokers without hearing loss (<26 dB) Mean \pm SD	Non-smokers of cigarettes and waterpipe without hearing loss (<26 dB) Mean \pm SD	p p-p-value significance
Total, n	219	113	808	
Vitamin D (ng/mL)	16.99 \pm 8.07	19.88 \pm 8.51	21.68 \pm 9.15	<0.001
Hemoglobin (g/dL)	12.78 \pm 1.67	13.76 \pm 1.63	14.04 \pm 1.96	<0.001
Magnesium (mmol/L)	0.66 \pm 0.08	0.78 \pm 0.08	0.97 \pm 0.09	<0.001
Potassium (mmol/L)	3.58 \pm 0.80	3.55 \pm 0.69	3.53 \pm 0.49	0.243
Calcium (mmol/L)	1.94 \pm 0.10	1.96 \pm 0.11	1.98 \pm 0.10	0.009
Phosphorous (mmol/L)	1.27 \pm 0.27	1.26 \pm 0.34	1.27 \pm 0.31	0.966
Creatinine (mmol/L)	75.47 \pm 15.34	75.47 \pm 15.34	74.22 \pm 14.16	0.643
Fasting Glucose (mmol/L)	7.29 \pm 1.46	7.29 \pm 1.46	6.30 \pm 1.34	<0.001
HbA1c	7.32 \pm 1.36	6.50 \pm 1.16	6.29 \pm 1.01	<0.001
Cholesterol (mmol/L)	4.73 \pm 0.86	4.71 \pm 0.86	4.80 \pm 0.88	0.265
HDL (mmol/L)	1.04 \pm 0.22	1.09 \pm 0.35	1.11 \pm 0.31	0.020
LDL (mmol/L)	1.82 \pm 0.68	1.971 \pm 0.83	1.89 \pm 0.83	0.324
Albumin (mmol/L)	41.88 \pm 3.85	41.48 \pm 4.12	42.28 \pm 5.10	0.179
Bilirubin (mmol/L)	7.59 \pm 2.60	6.99 \pm 2.12	7.33 \pm 2.62	0.130
Triglyceride (mmol/L)	1.66 \pm 0.69	1.66 \pm 0.66	1.64 \pm 0.71	0.958
Ferritin (mmol/L)	250.23 \pm 39.72	174.72 \pm 22.86	227.21 \pm 32.20	0.179
Uric acid (mmol/L)	273.89 \pm 2.56	294.35 \pm 58.31	283.49 \pm 67.60	0.023
Systolic BP (mmHg)	144.00 \pm 7.63	143.00 \pm 7.63	127.00 \pm 3.90	<0.001
Diastolic BP (mmHg)	87.89 \pm 8.33	87.89 \pm 8.33	79.15 \pm 7.31	<0.001
Microalbuminuria	11.78 \pm 3.25	11.75 \pm 3.35	8.69 \pm 1.65	<0.001
	n (%)	n (%)	n (%)	
Vitamin D level (25(OH)D ng/mL)				
Deficiency level (<20)	151 (68.9)	136 (68.3)	408 (50.2)	
Insufficiency level (20–29)	36 (16.4)	35 (17.6)	260 (32.2)	<0.001
Optimal level (>30)	32 (14.6)	28 (14.1)	142 (17.6)	

Table 4. Multivariate stepwise regression analysis for predictors of hearing impairment associated with cigarette smoking in stroke patients (N=1140)

Independent variables	B	SE	β	t-test	p
Vertigo (Yes)	0.423	0.035	0.325	11.974	<0.001
Obesity	0.015	0.003	0.134	5.039	<0.001
Vitamin D deficiency (<20 ng/mL)	0.006	0.002	0.101	3.802	<0.001
ATP III metabolic syndrome	0.170	0.049	0.117	3.476	<0.001
IDF metabolic syndrome	0.131	0.045	0.097	2.918	0.004
Calcium (mmol/L)	0.332	0.124	0.071	2.672	0.008
Headache and migraine (Yes)	0.073	0.035	0.056	2.064	0.039
Hypertension (Yes)	-0.070	0.031	-0.064	-2.251	0.025

SE: standard error.

microalbuminuria ($p<0.001$), systolic BP ($p<0.001$), and diastolic BP ($p<0.001$). Sleepiness was notably higher among cigarette smokers with hearing loss compared to non-smokers without hearing loss ($p=0.013$).

Table 4 outlines the multivariate regression analysis for predicting risk factors in cigarette smokers with hearing loss among stroke patients, identifying vertigo ($p<0.001$), obesity ($p<0.001$), vitamin D deficiency (<20 ng/mL) ($p<0.001$), ATP III Metabolic Syndrome ($p<0.001$), IDF Metabolic Syndrome ($p=0.004$), calcium (mmol/L) ($p=0.008$), headaches/migraines ($p=0.039$), and hypertension ($p=0.025$) as significant predictors among stroke patients.

DISCUSSION

This study revealed a significant association between cigarette smoking, waterpipe use, and hearing loss among stroke patients, consistent with previous studies^{3-10,12}. Exploring the factors related to smoking and hearing loss in stroke patients is crucial for preventing hearing loss. Reducing or quitting smoking could potentially prevent hearing issues^{3-10,12}. Hu et al.⁵ discovered that individuals who had quit smoking faced a lower risk of hearing loss compared to those who continued to smoke. Recently, Bener et al.^{1,12,16} confirmed the link between cigarette smoking and hearing ability deprivation among hypertension and stroke patients, aligning with this study’s findings.

This study also identified a strong correlation between obesity, comorbidities, and diminished hearing in cigarette as well waterpipe smokers,

which is consistent with previous findings^{8,12-16,20-21}. The results of this study align with previous research concerning stroke, hypertension, and tinnitus^{2-4,8,9,12-13}. Latest literature findings have indicated that hearing deterioration is rather prevalent among hypertension and diabetes patients in contrast to the healthy population^{1-14-16,20}.

The current survey indicated a notable positive association between hearing disease and obesity, which is in line with previously reported studies^{1,8,12,22}. The popularity of MP3 players for listening to music, as noted in this study, is consistent with another research²⁴.

A recent study⁵ reported significant variations in the burden of tracheal, bronchus, and lung (TBL) cancer across 204 countries and territories. While global age-standardized incidence, death, and disability-adjusted life years (DALY) rates are declining, some countries still show increasing trends in these rates.

Research by Dawes et al.¹¹, Bener et al.^{1,16,19}, and Bigman²⁰ suggested that increasing vitamin D levels can reduce hearing problems. Additionally, vitamin D deficiency has been linked to both low and high-frequency hearing loss in adults and the elderly¹⁸⁻²⁰. These findings align with the present study. Vitamin D performs a key role in the human auditory system, and its deficiency negatively affects the ears, particularly the inner ear¹⁸⁻²⁰. Overall, this study found that hypertension, vitamin D deficiency, and sleepiness were potential risk factors for hearing loss among smokers, suggesting the need for immediate prevention strategies through media campaigns.

Some studies have also observed a relationship between sleep disorders, hearing loss, and tinnitus²⁶.

Limitations

The study has some limitations. First, the cross-sectional design does not allow for determining causal relationships. Second, some patients were excluded due to the time required for audiometric assessments. Third, the smoking information was self-reported, which may introduce bias. Fourth, the sleepiness data obtained from the Epworth scale is subjective and may not be entirely accurate.

CONCLUSIONS

This study puts forward that smoking cigarette along with factors like hypertension, obesity, vitamin D deficiency, and sleepiness, serve as notable risks for losing hearing ability among stroke patients. There is increasing evidence linking cigarette tobacco smoking to lung cancer and various adverse health effects.

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ACKNOWLEDGEMENTS

The authors would like to thank the Medipol International School of Medicine, Istanbul Medipol University for their support.

CONFLICTS OF INTEREST

The authors have completed and submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest and none was reported.

FUNDING

There was no source of funding for this research.

ETHICAL APPROVAL AND INFORMED CONSENT

Ethical approval was obtained from the Institutional Review Board of Istanbul Medipol University (Approval number: R.5.IRB No. E-10840098-202.3.02-7291; Date: 30 November 2024). Participants provided informed consent.

DATA AVAILABILITY

The data sets used and/or analyzed in this study are available from the corresponding author on reasonable request.

AUTHORS' CONTRIBUTIONS

AB, AE and LH: study design, conceptualization, project administration. All authors: data curation, supervision, formal analysis, validation, writing of original draft, reviewing and editing of the manuscript. All authors read and approved the final version of the manuscript.

PROVENANCE AND PEER REVIEW

Not commissioned; externally peer-reviewed.