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RISK FACTORS FOR HEARING LOSS IN ADULTS PATIENTS AGED 18 YEARS AND MORE IN MOSUL CITY A CASE CONTROL STUDY

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ABSTRACT

Hearing loss is a common public health problem worldwide with a multifactorial etiology involving modifiable and non-modifiable risk factors, and identifying these determinants is crucial for prevention and early intervention; this case-control study aimed to assess the risk factors associated with sensorineural hearing loss among adults aged 18 years and more in Mosul City and included 300 participants (150 cases and 150 controls) recruited from the ENT consultation clinics of Al-Jumhori and Al-Salam Teaching Hospitals over six months starting from February 2025, with data collected through a structured questionnaire covering sociodemographic, behavioral, medical, and occupational risk factors and analyzed using SPSS version 26 with odds ratios (OR), 95% confidence intervals (CI), and chi-square/Fisher's exact tests. Age of 50 years and above, rural residence, illiteracy, low and middle socioeconomic status, outdoor/transportation and industrial/military occupations, current and passive smoking, hypertension, diabetes mellitus, use of anti-hypertensive and anti-diabetic medications, history of head and/or ear injury, and occupational noise exposure—particularly exposure exceeding 8 hours daily or 10 years cumulatively—were all significantly associated with an increased risk of hearing loss ($p < 0.05$), while higher education, high socioeconomic status, and healthcare/educational occupations were protective. Among cases, moderate and severe hearing loss were the most common severities (31.3% and 30.7%, respectively), and bilateral involvement predominated (81.3%). These findings indicate that hearing loss in this population is strongly associated with aging, rural residence, low educational and socioeconomic status, hazardous occupational exposure, smoking, chronic metabolic and vascular disease, trauma, and noise exposure and highlight the need for targeted preventive and educational interventions.

KEYWORDS: Sensorineural hearing loss; Risk factors; Case-control study; Noise exposure; Presbycusis; Mosul.

1. INTRODUCTION

Hearing loss is an increasingly significant global public health issue affecting individuals across all age groups. According to the World Health Organization, over 1.5 billion people worldwide currently experience some degree of hearing impairment, a figure projected to rise to 2.5 billion by 2050.[1] It is the most common sensory deficit worldwide, affecting approximately 5% of the population and exacting a considerable personal and societal cost through impaired communication, cognitive and emotional well-being, and quality of life.[2]

1.1 Definition and Classification

Hearing loss is defined as a hearing threshold of 26 dB or worse and may be conductive, sensorineural, or mixed in origin.[4] Epidemiologic studies have identified both non-modifiable risk factors, such as cochlear aging and genetic predisposition, and modifiable risk factors, including occupational and recreational noise exposure, ototoxic medications, smoking, and socioeconomic status, as well as medical conditions such as hypertension, diabetes mellitus, stroke, and chronic kidney or liver disease.[3] Age-related hearing loss (presbycusis) alone affects approximately 15% of American adults, rising to nearly one in three individuals

aged 65-74 years and about half of those older than 75 years.[5]

Mechanistically, age-related and noise-induced sensorineural hearing loss result from progressive degeneration of cochlear outer and inner hair cells, atrophy of the stria vascularis, and loss of spiral ganglion neurons, processes that are accelerated by vascular risk factors such as hypertension and diabetes mellitus, by ototoxic drug exposure, and by cumulative noise trauma.[3, 4] Because several of these contributory pathways are potentially modifiable, identifying which risk factors predominate in a given population is an essential step toward designing effective preventive and screening programs.

1.2 Study Rationale

In many low- and middle-income countries, hearing loss frequently goes undetected and untreated, underscoring the need to characterize the risk factors specific to local populations in order to guide culturally and regionally appropriate screening and preventive strategies.[1] Despite the considerable burden of hearing loss and its impact on communication, social participation, and quality of life, recent epidemiological data on this condition remain scarce in Mosul City, Iraq.

1.3 AIM OF THE STUDY

This study aimed to assess the risk factors associated with sensorineural hearing loss among adults aged 18 years and more in Mosul City.

1.4 Specific Objectives

1. To identify the sociodemographic characteristics of the study sample and their relation to hearing loss.
2. To evaluate the association between behavioral factors and hearing loss.
3. To investigate the impact of ototoxic medication exposure on hearing function.
4. To examine the relationship between chronic medical conditions and the risk of hearing loss.
5. To classify sensorineural hearing loss among cases by laterality and severity based on audiometric evaluation.

2. Study Setting and Design

A case-control study was conducted in the Ear, Nose, and Throat (ENT) consultation clinics of Al-Jumhori Teaching Hospital and Al-Salam Teaching Hospital in Mosul City, the center of Nineveh Governorate in Northern Iraq. Official approval was obtained from the Arab Board of Health Specializations and the Nineveh Health Directorate, and verbal consent was obtained from each participant before data collection; confidentiality of all information was maintained throughout the study.

A pilot study of 20 participants (10 cases and 10 controls) was conducted beforehand to assess questionnaire completeness and feasibility; based on its feedback, a question on alcohol consumption was removed because of participant discomfort in responding.

2.1 Study Period

The study was conducted over approximately six months, from February 2025 to July 2025. Data collection took place during the first four months, with two to three visits per week to the ENT consultation units, followed by two months of data analysis.

2.2 Study Sample and Sampling Technique

The study included 300 adults recruited by non-randomized convenience sampling: 150 cases and 150 controls. Cases were patients attending the ENT clinics with a chief complaint of hearing loss, confirmed by audiometric testing to be sensorineural hearing loss, with a pure-tone average greater than 25 dB at 500, 1000, and 2000 Hz.

Exclusion criteria: individuals with congenital hearing loss, tympanic membrane perforation, prior ear surgery, treatable causes of hearing loss (wax, foreign body, fungal or acute otitis media/externa), or an audiogram showing conductive or mixed hearing loss.

Controls were patients attending the same clinics with complaints other than hearing loss and normal hearing confirmed audiometrically (pure-tone average $\leq$ 25 dB in both ears at the same frequencies), matched to cases by the same adult age range.

2.3 Data Collection Tool

A structured questionnaire was used to collect data through direct interview, covering seven domains: sociodemographic factors (age, gender, residence, occupation, education); behavioral risk factors (smoking); past medical history of diabetes mellitus and hypertension; medication history; history of head and/or ear injury; occupational and environmental noise exposure and its duration; and audiometric results (type, severity, and laterality of hearing loss).

Pure-tone audiometry was performed for all participants at the ENT consultation clinics to confirm eligibility and to classify the type, severity, and laterality of hearing loss among cases. Severity was graded according to standard pure-tone average thresholds into mild, moderate, severe, and profound categories, and laterality was classified as bilateral, unilateral right, or unilateral left.

2.4 Variable Definitions

Socioeconomic status (SES) was calculated using the equation: SES = Education + Occupation + (House ownership × 0.5) + (Car ownership × 0.1) + [(Age - 20)/100] - Retired/unemployed/deceased, in which education is scored from zero (illiterate) to seven (PhD or equivalent); occupation is scored across six main categories used in Iraq; and house/car ownership are each scored between zero and one.[6] The resulting score

was divided into three equal categories, shown in Table 1.

Table 1: Classification of the socioeconomic status (SES) score.

SES category	Score range
Low SES	0 - 4.7
Middle SES	4.8 - 9.4
High SES	9.5 - 14.05

Current smokers were defined as adults who had smoked at least 100 cigarettes in their lifetime and continued to smoke; former smokers as those who met this criterion but had quit; never smokers as those who had never smoked or smoked fewer than 100 cigarettes in their lifetime; and passive smokers as those regularly exposed to secondhand smoke.[7] Diabetes mellitus was diagnosed according to WHO criteria (random blood glucose >200 mg/dl with symptoms, fasting blood glucose >126 mg/dl, HbA1c >6.5%, or current use of anti-diabetic medication)[8], with duration since diagnosis categorized as 1-5, 6-10, or more than 10 years. Systemic hypertension was defined as systolic blood pressure >140 mmHg, diastolic blood pressure >90 mmHg, or current use of antihypertensive medication[9], with duration categorized as ≤5 years or >5 years. Outdoor and transportation workers included construction workers, welders, blacksmiths, carpenters, traffic policemen, drivers, soldiers, and freelancers.

3. Statistical Analysis

Data were analyzed using the Statistical Package for the Social Sciences (SPSS), version 26. The Pearson chi-square test was used to assess associations between categorical variables, and Fisher's exact test was used instead when an expected cell value was less than five. Frequencies, means, and standard deviations were calculated, and numerical data were compared using the independent t-test. A p-value <0.05 was considered statistically significant. The odds ratio (OR), with its 95% confidence interval (CI), was calculated as a measure of association between each risk factor and the occurrence of hearing loss.

Level of significance

For all the above-mentioned statistical tests, the level of significance was set at 5% (p-value).

- p-value >0.05 indicates a non-significant result.
- p-value ≤0.05 indicates a significant result.
- p-value ≤0.01 indicates a highly significant result.
- p-value ≤0.001 indicates a very highly significant result.

4. RESULTS

The study included 300 adults: 150 cases and 150 controls. The mean age of cases (55.24 ± 15.48 years; range 18-85) was significantly higher than that of controls (39.34 ± 13.45 years; range 18-66; p < 0.001). Among cases, 100 (66.7%) were male and 50 (33.3%) female (male: female ratio 2.00:1.00), compared with 83 (55.3%) male and 67 (44.7%) female controls (ratio 1.24:1.00), as shown in Table 2.

Table 2: Mean age and gender distribution of the study sample (n=300).

	Cases Mean±SD	Controls Mean±SD	P*
Age (yrs)	55.24±15.48	39.34±13.45	<0.001
M: F ratio	2.00:1.00	1.24:1.00	-
Male n(%)	100 (66.7)	83 (55.3)	-
Female n(%)	50 (33.3)	67 (44.7)	-

**Independent t-test*

A statistically significant association with hearing loss was found for age groups 50-59 years (OR=3.37, p<0.001) and ≥60 years (OR=4.58, p<0.001), while younger age groups (18-39) showed significantly lower odds and the 40-49 group showed no significant association (p=0.208). Males had a significantly higher risk than females (OR=1.61, p=0.044), and rural residents had a significantly higher risk than urban residents (OR=1.86, p=0.046) (Table 3). Illiteracy was strongly associated with hearing loss (OR=12.5, p<0.001), while higher (university and above) education (OR=0.4, p<0.001) and high socioeconomic status (OR=0.09, p<0.001) were protective. Outdoor/transportation and industrial/military occupations increased the risk (OR=2.28, p=0.003), while healthcare and educational occupations were protective (OR=0.08, p<0.001) (Table 4).

Table 3: Demographic characteristics between adults with and without hearing loss (n=300).

Factor	Cases n(%)	Ctrl n (%)	OR (95% CI)	P
Age, years				
18-29	11(7.3)	40(26.7)	0.22(0.11-0.44)	<0.001
30-39	17(11.4)	47(31.3)	0.28(0.15-0.52)	<0.001
40-49	20(13.3)	28(18.7)	0.67(0.36-1.25)	0.208
50-59	34(22.7)	12(8.0)	3.37(1.67-6.81)	<0.001

≥60	68(45.3)	23(15.3)	4.58(2.65-7.92)	<0.001
Gender				
Female	50(33.3)	67(44.7)	1.61(1.01-2.58)	0.044
Male	100(66.7)	83(55.3)	Ref.	-
Residence				
Rural	32(21.3)	19(12.6)	1.86(1.01-3.47)	0.046
Urban	118(78.7)	131(87.4)	Ref.	-

**Chi-square test*

Table 4: Socio-economic factors between adults with and without hearing loss (n=300).

Factor	Cases n(%)	Ctrl n (%)	OR (95% CI)	P
Education				
Illiterate	21(14.0)	2(1.3)	12.5(2.77-52.4)	<0.001
Primary	51(34.0)	36(24.0)	1.63(0.98-2.70)	0.056
Secondary	50(33.3)	57(38.0)	0.82(0.51-1.31)	0.399
University+	28(18.7)	55(36.7)	0.40(0.23-0.67)	<0.001
Occupation				
Outdoor/transport	47(31.3)	25(16.7)	2.28(1.32-3.96)	0.003
Industrial/military	35(23.3)	0(0)	-	<0.001
Office workers	12(8.0)	22(14.7)	0.51(0.24-1.06)	0.069
Healthcare/education	4(2.7)	37(24.6)	0.08(0.03-0.24)	<0.001
Retired/homemaker	52(34.7)	66(44.0)	0.68(0.42-1.08)	0.098
SES				
Low	49(32.7)	43(28.7)	1.21(0.74-1.97)	0.453
Middle	97(64.6)	72(48.0)	1.98(1.25-3.15)	0.004
High	4(2.7)	35(23.3)	0.09(0.03-0.26)	<0.001

**Chi-square **Fisher exact*

Current smokers (OR=1.93, p=0.016) and passive smokers (OR=3.55, p=0.002) had significantly higher risk, while never-smokers were protected (OR=0.28, p<0.001); among current smokers, those with more than 33 pack-years had significantly higher risk (OR=4.89, p=0.016) (Table 5).

Hypertension (OR=2.58, p<0.001)—particularly with a duration exceeding 5 years (OR=3.22, p=0.026)—and diabetes mellitus (OR=5.95, p<0.001) were both significantly associated with hearing loss, though diabetes duration itself was not significantly associated (Table 6).

Overall medication use was significantly associated with hearing loss (OR=4.71, p<0.001); both anti-hypertensive medications (OR=2.95, p<0.001) and anti-diabetic medications (OR=5.41, p<0.001) were independently associated with increased risk (Table 7).

Table 5: Behavioral risk factors between adults with and without hearing loss (n=300).

Smoking	Cases n(%)	Ctrl n (%)	OR (95% CI)	P
Current	46(30.7)	28(18.7)	1.93(1.13-3.30)	0.016
Former	31(20.7)	20(13.3)	1.69(0.92-3.13)	0.091
Passive	25(16.6)	8(5.3)	3.55(1.55-8.15)	0.002
Never	48(32.0)	94(62.7)	0.28(0.17-0.45)	<0.001
Pack-years				
≤10	6(13.0)	16(57.1)	0.11(0.04-0.35)	<0.001
11-33	23(50.0)	9(32.2)	2.11(0.79-5.63)	0.133
>33	17(37.0)	3(10.7)	4.89(1.28-18.6)	0.016

**Chi-square **Fisher exact; pack-years among current smokers only*

Table 6: Medical history between adults with and without hearing loss (n=300).

Medical history	Cases n(%)	Ctrl n (%)	OR (95% CI)	P
Hypertension				
Present	51(34.0)	25(16.7)	2.58(1.49-4.45)	<0.001
Absent	99(66.0)	125(83.3)	Ref.	-
Dur. ≤ ≤5 yrs	10(19.6)	11(44.0)	3.22(1.13-9.20)	0.026
Duration: >5 yrs	41(80.4)	14(56.0)	Ref.	-

Diabetes mellitus				
Present	57(38.0)	14(9.3)	5.95(3.14-11.3)	<0.001
Absent	93(62.0)	136(90.7)	Ref.	-
Duration: 1-5 yrs	8(14.0)	3(21.4)	0.60(0.14-2.63)	0.494
Dur. 6-10 yrs	14(24.6)	5(35.7)	0.59(0.17-2.04)	0.430
Duration: >10 yrs	35(61.4)	6(42.9)	2.12(0.65-6.94)	0.218

**Chi-square **Fisher exact*

Table 7: Medication use between adults with and without hearing loss (n=300).

Medications	Cases n(%)	Ctrl n (%)	OR (95% CI)	P*
Use of medication				
Present	87(58.0)	34(22.7)	4.71(2.85-7.78)	<0.001
Absent	63(42.0)	116(77.3)	Ref.	-
Type				
Anti-hypertensive	45(30.0)	19(12.7)	2.95 (1.63-5.35)	<0.001
Antidiabetic	48(32.0)	12(8.0)	5.41(2.74-10.7)	<0.001
Miscellaneous	11(7.3)	9(6.0)	1.24(0.50-3.08)	0.643

**Chi-square test*

A history of head and/or ear injury was significantly more common among cases (17.3% vs. 3.3%; OR=6.08, 95% CI 2.27-16.31, p<0.001) (Table 8).

Table 8: History of head and/or ear injury (n=300).

Head/ear injury	Cases n(%)	Ctrl n (%)	OR (95% CI)	P*
Present	26(17.3)	5(3.3)	6.08(2.27-16.3)	<0.001
Absent	124(82.7)	145(96.7)	Ref.	-

**Chi-square test*

Exposure to loud noise showed a strong association with hearing loss (OR=12.17, p<0.001). Although chronic workplace and acute exposure did not differ significantly (p=0.090), daily exposure exceeding 8 hours was strongly associated with hearing loss (OR=37.5, p<0.001), and cumulative exposure of 10 years or more showed the strongest association (OR=56.0, p<0.001), while shorter durations were not significant (Table 9).

Table 9: Exposure to loud noise between adults with and without hearing loss (n=300).

Noise exposure	Cases n(%)	Ctrl n (%)	OR (95% CI)	P
Present	61(40.7)	8(5.3)	12.17(5.56-26.6)	<0.001
Absent	89(59.3)	142(94.7)	Ref.	-
Type				
Chronic	54(88.5)	8(100)	-	0.090
Acute	7(11.5)	0(0)	-	-
Hrs/day (chronic)				
<8 hrs	4(7.5)	6(75.0)	37.5(5.63-250)	<0.001
>8 hrs	50(92.5)	2(25.0)	Ref.	-
Years (chronic)				
1-4 yrs	0(0)	5(62.5)	-	<0.001
5-9 yrs.	6(11.1)	2(25.0)	0.38(0.06-2.29)	0.273
≥10 yrs	48(88.9)	1(12.5)	56.0(5.84-537)	<0.001

**Chi-square **Fisher exact*

Among the 150 cases, moderate hearing loss was the most common severity (47 cases; 31.3%), followed by severe (46; 30.7%), profound (42; 28.0%), and mild hearing loss (15; 10.0%) (Figure 1).

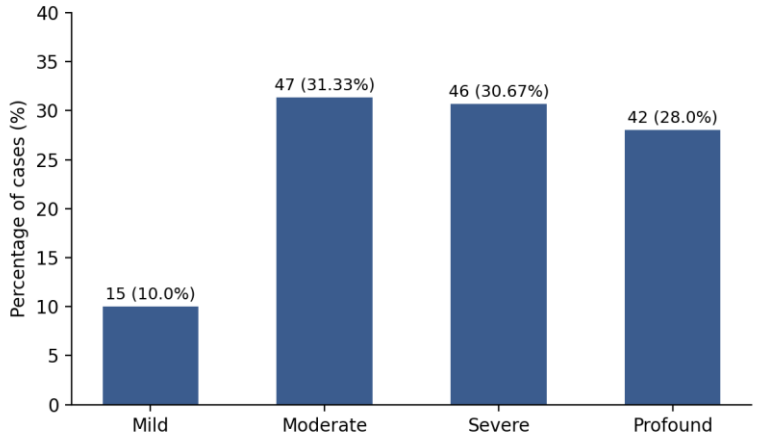

Figure 1: Distribution of hearing loss severity among cases (n=150).

Regarding laterality, bilateral hearing loss predominated (122 cases; 81.3%), while unilateral left (17; 11.3%) and unilateral right (11; 7.3%) hearing loss were less common (Figure 2).

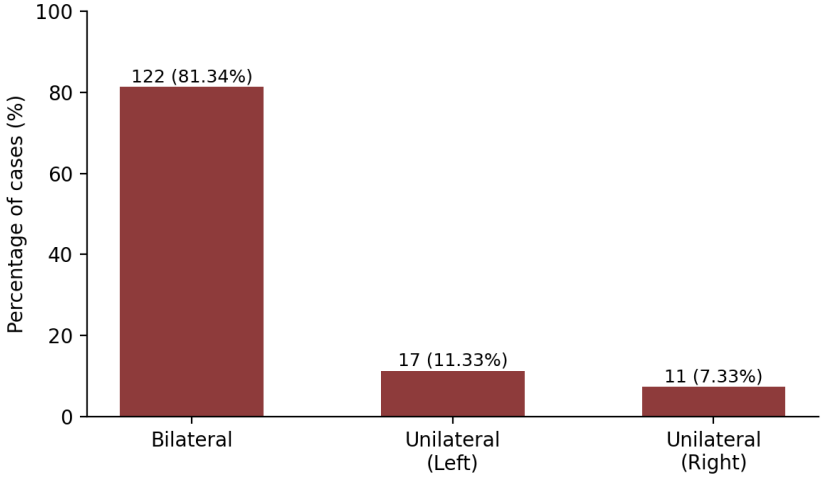

Figure 2: Distribution of hearing loss laterality among cases (n=150).

5. DISCUSSION

This case-control study examined the association between sensorineural hearing loss and a range of demographic, socioeconomic, behavioral, medical, and occupational factors among adults aged 18 years and more in Mosul City.

5.1 Demographic Factors

Age was significantly associated with hearing loss, with individuals aged ≥60 years having more than four times the risk of younger groups, consistent with a 2024 Jordanian study reporting a marked rise in prevalence after age 50[10] and a global analysis of Global Burden of Disease data identifying age as the strongest contributor to hearing loss worldwide.[11] Males had approximately 1.6 times the risk of females, in line with a 10-year cohort study reporting higher incidence among men[12] and United States prevalence data showing consistently higher rates in males across severity levels.[13] Rural residents had nearly twice the risk of urban residents, which may reflect limited access to healthcare services and lower awareness of hearing protection; a comparable pattern was reported in rural Western Australia, attributed to inadequate workplace hearing protection and reduced audiology service availability.[14] Taken together, these demographic associations suggest that the cumulative biological effect of aging on the auditory system is compounded by gender-related occupational and lifestyle exposures and by geographic disparities in access to ear care services.

5.2 Socio-economic Factors

Illiteracy carried more than a twelve-fold increased risk, while higher education was protective, consistent with US findings that adults with hearing loss were markedly less likely to have completed high school[15] and NHANES trend data confirming higher prevalence among adults with lower education regardless of other factors.[16] Outdoor/transportation and industrial/military occupations carried significantly elevated risk, in agreement with a Norwegian systematic review establishing occupational noise as a well-documented

cause of hearing loss with a clear dose-response relationship[17], whereas healthcare and educational occupations were protective, reflecting their lower noise exposure. Middle and low socioeconomic status carried increased risk, while high socioeconomic status was strongly protective, in agreement with population-based evidence from China[18] and Iran[19] linking lower socioeconomic status to reduced healthcare access, greater occupational noise exposure, and a higher burden of comorbidities. Illiteracy and low income may also delay care-seeking for early hearing symptoms and limit awareness of preventive measures such as hearing protection devices, compounding the biological risk conferred by hazardous occupations.

5.3 Behavioral Factors

Smoking emerged as the most significant behavioral risk factor, with current and passive smokers at significantly elevated risk and never-smokers protected, consistent with a large UK population study reporting higher odds of hearing loss among both active and passively exposed smokers, attributed to the direct ototoxic effects of nicotine and smoke-related vascular changes reducing cochlear oxygen supply.[20] The dose-response relationship observed with pack-years in the present study further supports a cumulative toxic effect of tobacco exposure on cochlear microcirculation rather than a purely confounded association.

5.4 Medical Factors and Medication Use

Hypertension carried more than double the risk, increasing further with disease duration exceeding five years, consistent with findings from Beijing attributing this association to reduced inner-ear blood flow.[21] Diabetes mellitus carried nearly a six-fold increased risk, in agreement with a Korean cohort study linking diabetes to vascular and neural damage within the auditory system[22], although diabetes duration itself was not significantly associated with hearing loss in the present study. Medication use overall, and anti-hypertensive and anti-diabetic medications specifically, were significantly associated with increased risk, consistent with prior evidence on the ototoxic potential of various drug classes, including analgesics[23] and antidepressants[24], although a protective association between metformin use and hearing loss has also been reported[25], suggesting that the underlying chronic disease rather than the medication itself may drive part of this association.

5.5 History of Head and/or Ear Injury

A history of head and/or ear injury carried more than a six-fold increased risk of hearing loss, consistent with evidence of high rates of auditory impairment following blast injury[26] and nationwide cohort data linking traumatic brain injury to substantially elevated long-term risk of hearing loss.[27]

5.6 Exposure to Loud Noise

Occupational noise exposure carried more than a twelve-fold increased risk overall, rising further with daily exposure exceeding 8 hours and cumulative exposure of 10 years or more, consistent with a high prevalence of noise-induced hearing loss reported among Iraqi textile workers with persistent occupational exposure.[28]

5.7 Severity and Laterality of Sensorineural Hearing Loss

Moderate and severe hearing loss were the most prevalent severities among cases, consistent with global estimates from the 2019 Global Burden of Disease Study identifying moderate hearing loss as the most common severity level.[29] Bilateral hearing loss predominated over unilateral involvement, matching South Korean population-based data in which bilateral hearing loss was more prevalent than unilateral involvement[30], suggesting that shared etiologies such as age-related degeneration, systemic disease, and noise exposure commonly affect both ears simultaneously.

5.8 Strengths and Limitations

This study provides valuable insight into previously unexamined modifiable risk factors for sensorineural hearing loss among adults in Iraq, which may inform future analytical or interventional research in Mosul and nationally. Its main strengths include the use of audiometrically confirmed case and control definitions rather than self-reported hearing status, a structured questionnaire covering a broad range of demographic, behavioral, medical, and occupational domains, and a pilot-tested data collection tool that improved the clarity and feasibility of data collection.

However, its case-control design limits causal inference; recall bias may have affected reporting of past exposures such as noise duration and smoking history; and the relatively small, single-city sample recruited by convenience rather than random sampling may limit generalizability to the wider Iraqi population. In addition, potential confounding between overlapping risk factors, such as occupation, socioeconomic status, and noise exposure, could not be fully disentangled using univariate analysis alone.

6. CONCLUSION AND RECOMMENDATIONS

Sensorineural hearing loss among adults in Mosul City was significantly associated with advancing age, male gender, and rural residence; with illiteracy, low and middle socioeconomic status, and outdoor/transportation and industrial/military occupations; with current and passive cigarette smoking; with hypertension, diabetes mellitus, and use of antihypertensive and antidiabetic medications; with a history of head and/or ear injury; and with occupational exposure to loud noise, particularly exposure exceeding 8 hours daily or 10 years cumulatively. Among cases, moderate and severe hearing loss were the predominant severities, and bilateral involvement was the most common laterality pattern.

Based on these findings, we recommend developing

targeted health education and awareness campaigns on early detection and prevention of hearing loss, particularly for low-education and low-income communities, and strengthening hearing care services and outreach in rural areas. Workplace noise regulations should be enforced, protective equipment use encouraged, and regular hearing check-ups promoted among workers in high-risk occupations, together with routine hearing screening for older adults and those with diabetes or hypertension. Smoking cessation programs and improved management of chronic hypertension and diabetes should be prioritized among high-risk populations, alongside broader community awareness campaigns on lifestyle and environmental contributors to hearing loss. Finally, further research with larger samples is recommended to clarify the role of ototoxic medications and other less-studied risk factors and to develop prevention and rehabilitation strategies tailored to the local population.

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