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Original Article

Prevalence and Factors Associated With Hearing Loss and Hearing Aid Use in Korean Elders

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Abstract

Background: This study examined hearing loss prevalence and hearing aid usage rates among Korean elders by comparing the differences between those with and without hearing loss, and between those who used and did not use hearing aids.

Methods: This study was based on data collected during the Korean National Health and Nutrition Examination Survey V (2010–2012). The study sample consisted of 5,447 Koreans aged ≥60 years who received a hearing assessment. Hearing loss was measured using a pure tone audiometry test and classified according to the World Health Organization's criteria. Hearing aid use was assessed by self-report. Multiple logistic regression analyses were performed to determine the associations between hearing loss, hearing aid use, and related variables.

Results: Hearing loss was found in 16.8% of the elders and only 15.9% of them used a hearing aid. Male (95% CI: 1.27–2.15), tinnitus (95% CI: 1.58–2.32), dizziness (95% CI: 1.05–1.73), and occupational noise exposure (95% CI: 1.32–2.38) were the variables most strongly associated with hearing loss after multivariate adjustment. Tinnitus (95% CI: 1.34–4.13) and occupational noise exposure (95% CI: 1.01–5.02) were strongly associated with hearing aid use after multivariate adjustment.

Conclusion: More than half of South Korean elders aged ≥60 and older have hearing loss but the rate of hearing aid use is very low. An aural public health program should address modifiable risk factors, such as tinnitus and noise exposure, and non-modifiable risk factors associated with hearing loss in the elderly.

Keywords: Elderly, Hearing aid, Hearing loss, Prevalence, Korea

Introduction

Hearing loss is a significant public health problem due to its high prevalence among the elderly (1, 2). The causes of hearing loss include organic, environmental, and health-related factors, such as genetic predisposition (3–5), noise exposure (4, 5), ototoxic drug use, and cardiovascular disease (3, 6). The prevalence of hearing loss dramatically increases with age (6). A considerable number of studies have found that age-related hearing loss in elders is associated with limited activity, social isolation due to impaired cognition (7, 8), depressive symptoms (4, 9), falls (10–12), dementia (13), and a decrease in quality of life (14, 15). Therefore, proactive efforts are needed to identify the risk factors for hearing loss in the elderly, and develop measures to prevent negative consequences.

A hearing aid or a sound amplifier improves the communication of people with hearing loss and enhances their quality of life while mitigating social isolation and depressive symptoms (16, 17). Despite the advantages of hearing aids, elderly people are hesitant to seek professional help for their hearing problems, and tend to underestimate the negative consequences of hearing loss (18). Only 10–30% of elders with hearing loss use these aids (1, 19–21). As of 2009, 11.3% of Koreans aged 65 and older with hearing difficulties (40 dB threshold) used hearing aids (22), a much lower

rate than that found in other countries, although the representativeness of the sample is questionable.

A more serious problem is that hearing loss and its potential negative consequences in the rising population of elders worldwide are expected to grow in the future. However, the number of national studies on its prevalence and hearing aid use is insufficient (1, 16, 19, 21). Although South Korea also has this problem, there are few domestic studies on elders' hearing problems. These domestic studies define hearing loss according to the subjective feelings of discomfort reported by individuals, or use a different threshold of hearing loss (23–25) in the audiometric assessment of hearing, thus making them incomparable to national studies on a global level.

The present study utilized the Korean National Health and Nutrition Examination Survey KNHANES V (2010–2012) to examine hearing loss prevalence, hearing aid usage rates, and the factors associated with hearing loss and hearing aid usage among Koreans at least 60 years of age. The difference between hearing loss status and subjective hearing status also was investigated.

Materials and Methods

Study population

This study was based on data collected during the KNHANES V (2010–2012), a cross-sectional and nationally representative study. Multistage stratified cluster sampling to select household units among non-institutionalized civilians in Korea was conducted by the Korea Centers for Disease Control and Prevention (KCDC), to assess national health and nutritional levels. Data from this 3-year survey were obtained from an independent probability sample representing the entire nation, and a rolling sampling survey was used so that samples with similar year-specific characteristics were selected. The KNHANES V (2010-2012) consisted of a health interview survey, a health examination survey, and a nutrition survey. In the 1st year of the 5th round (2010), 10,938 people were sampled and 8,958 (81.9%) agreed to participate in the study. Of the 10,589 people sampled in the 2nd year, 8,518 (80.4%) agreed to participate, and of the 10,589 people sampled in the 3rd year (2012), 7,645 (75.9%) agreed to participate (22, 26, 27). All participants provided written informed consent; the KCDC Institutional Review Board approved the study's protocol. We submitted a data use plan and a written pledge on the KNHANES homepage, and received KCDC approval to use the data. Of the 6,455 people aged 60 or over who were included in the KNHANES V (2010–2012), 1,008 who had not received a hearing test were excluded from this study; therefore, data from 5,447 people were analyzed for this study.

Measures

Hearing status and hearing aid use

A trained examiner (medical physician) in a booth of a mobile examination center performed the pure tone audiometry (PTA) test for the KNHANES V survey. Hearing threshold values were measured at frequencies of 0.5, 1, 2, 3, 4, and 6 kHz. To ensure the hearing test's validity, the medical physician who conducted it received training from the Korean Society of Otorhinolaryngology-Head and Neck Surgery. A quality control report verifying the quality of the audiometer and audiometric booth was posted on the KNHANES homepage (28). Hearing loss severity was classified according to the American Speech-Language Hearing Association guidelines, by dividing the PTA of speech frequency (0.5, 1, 2, and 4 kHz) into normal hearing (≤ 25 dB), mild loss (25 < dB ≤ 40), moderate loss (40 < dB ≤ 70), and severe loss (>70 dB) (29). Hearing loss is classified as unilateral and bilateral (based on the better ear), and this study employed the World Health Organization's (WHO) definition: speech frequency PTA in the better ear with a 40 dB threshold (30).

Subjective hearing status was measured using the survey question "Which sentence best describes your hearing status (while using no hearing aid)?" which had four possible responses: (i) "Don't feel uncomfortable at all," (ii) "A little bit uncomfortable," (iii) "Very uncomfortable," and (iv) "Can't hear at all." Hearing aid use was measured by the question, "Do you currently use any hearing aid or

artificial cochlear?" which required a Yes or No response.

Other study variables

Data were collected on the participants' general and socioeconomic characteristics, including age, gender, living area, educational status, spouse, and economic status. Educational status was classified as high if the respondent finished education beyond middle school (higher than 7th grade). Their living areas were classified as urban or rural. Living with a spouse was classified as "yes" if they did, or "no" if they did not because they were single, separated, divorced, or widowed. Household economic status was calculated by the equivalent income for the bottom 25%, which calculates household income according to the number of household members.

The participants' health behaviors, including smoking, drinking, and regular physical activity were assessed. Smoking status was determined by the participants' reports of whether they had never smoked, had smoked in the past, or were current smokers. The amount of pure alcohol consumed was calculated in grams per day, according to the average number of alcoholic beverages consumed and the frequency of alcohol consumption. Participants who consumed an average of 1 to 15 g/day of alcohol were considered mild to moderate drinkers and those who consumed more than 30 g/day were considered heavy drinkers (31). Regular exercise was defined as strenuous physical activity performed for at least 20 min at one time at least three times a week.

The health-related measures included stress, depression, suicidal thoughts, falls, tinnitus, dizziness, obesity, hypertension, and diabetes. Stress was classified by categorizing the responses to the statements "I feel a considerable amount of stress," "I feel much stress," and "I feel a little stress" as "Yes." "I hardly feel any stress" was categorized as "No." Depressive symptoms were measured by the question, "Have you felt sad or depressed for at least 2 consecutive weeks within the past year, to the extent that it interfered with your daily life?" which required a "Yes" or "No" response. Suicidal ideation was assessed by the question, "Have you thought of committing suicide during the past year?" requiring a "Yes" or "No" response. Falls were assessed by asking, "Have you experienced a fall in the past year that was serious enough to go to an emergency room or hospital for treatment?" which required a "Yes" or "No" response. Obesity was defined as a body mass index above 25.0 kg/m^2 (32). Blood pressure was classified as high with a systolic blood pressure of >140 mmHg, a diastolic blood pressure of >90 mmHg (33), or taking prescribed bloodpressure medication. The presence of diabetes was confirmed with a fasting glucose >126 mg/dL, according to the guidelines of the Korean Diabetes Association (34), by a physical examination, or by taking prescribed medication with hypoglycemic agents or insulin injections.

Noise-related characteristics referred to noise exposure inside and outside the workplace and momentary noise exposure. Participants answered questions about their experiences of working at least 3 months at a place with loud noise from a machine or generator and being exposed to a loud noise for at least 5 hours a week outside of the workplace, or to any momentary loud noise such as from a gun or explosive.

A report verifying the quality control measures undertaken with the persons conducting the surveys was posted on the KNHANES homepage to convey the validity of the data collected in the health interview, health behavior, and health examination surveys.

Statistical analyses

Statistical analyses were conducted using SAS survey procedures (version 9.3; SAS Institute, Cary, N.C., USA) in a manner that reflected the sampling weights and provided nationally representative estimates according to the KCDC guidelines (26). Hearing loss prevalence and hearing aid use rates were expressed as frequencies and percents (SE). Survey weights were included to obtain the SEs of prevalence. Participants' demographic, health behavior, health-related and noise-related characteristic, differences between hearing loss and hearing aid use were analyzed with the Student's *t*-test or χ^2 test, as appropriate, using the

SURVEYMEANS or SURVEYFREQ procedures in SAS to reflect the study weights. Logistic regression analyses were used to determine the associations between hearing loss or hearing aid use and the related variables. Odds ratios (ORs) and confidence intervals were estimated after adjusting for age. Variables with a $P < 0.15$ in the age-adjusted analyses were selected for multivariate analyses. A P-value < 0.05 was considered statistically significant.

Results

Prevalence of hearing loss and hearing aid use

Hearing loss (in the better ear) in people aged 60 and older was mild (32.4%), moderate (15.0%), and severe (1.8%). The rate of hearing aid use for overall hearing loss cases (in the better ear with 25 dB) was only 5.3%, and 15.9% for moderate or more serious hearing loss (in the better ear with 40 dB) (Table 1). Hearing loss tended to rise rapidly with age, with 6.5% of the 60–64 age group exhibiting hearing loss compared to 46.0% in the 80 and older age group. The 60–64 age group showed the highest rate of hearing aid use (16.5%) but it was low given the overall prevalence of hearing loss (Fig. 1). When the actual hearing test outcomes were compared with the subjective assessments of hearing status, 37.6% of those who claimed not to have a hearing problem had mild to severe hearing loss; and 14.5% of those who answered, "Can't hear at all," had normal hearing (Fig. 2).

Table 1: Prevalence of hearing loss by grade and hearing aid use (n = 5,447)

Hearing loss	Frequency	Percent (SE)
Normal	2,834	50.8 (0.9)
Mild loss	1,726	32.4 (0.8)
Moderate loss	795	15.0 (0.6)
Severe loss	92	1.8 (0.2)
Hearing aid use*		
No	746	84.1 (0.5)
Yes	141	15.9 (0.5)

*Hearing loss is defined by the speech frequency PTA in the better ear with a 40 dB threshold.

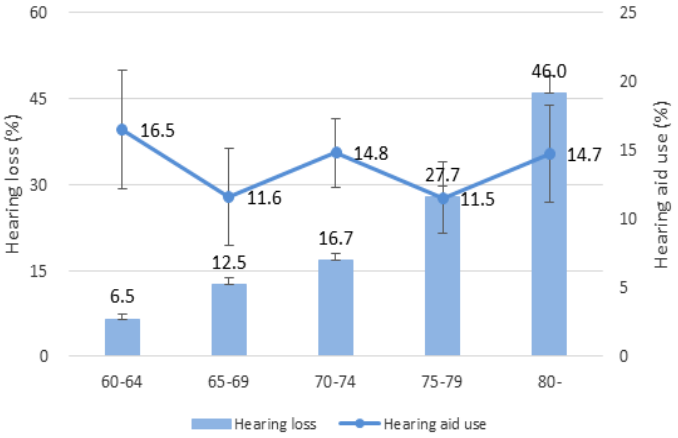

Fig. 1: Hearing loss and hearing aid use by age group (n = 5,447)

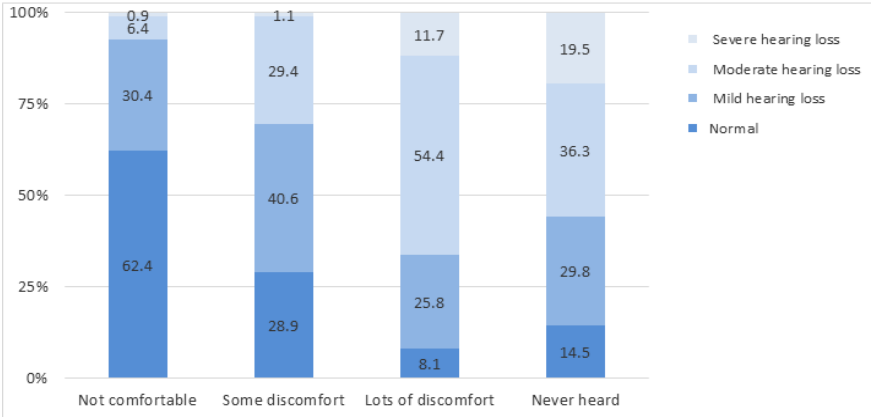

Fig. 2: Differences between hearing loss status and subjective assessment of hearing status in the Korean elders (n = 5,447)

Table 2: Characteristics of the hearing loss group and hearing aid use group (n = 5,447)

Variables	Classification	Hearing loss*			Hearing aid use*		
		No (n = 4,560)	Yes (n = 887)	*P*-value	No (n = 746)	Yes (n = 141)	*P*-value
Age (yr.)		68.5 ± 0.1	73.8 ± 0.3	<.001	73.8 ± 0.3	73.6 ± 0.8	0.774
Sex (%)	Male	43.2 (0.8)	50.5 (2.1)	0.002	44.2 (0.7)	55.4 (5.9)	0.062
	Female	56.8 (0.8)	49.5 (2.1)		55.8 (0.7)	44.6 (5.9)	
Living place (%)	Rural	29.7 (2.4)	35.1 (3.3)	0.021	30.4 (2.4)	38.8 (6.5)	0.151
	Urban	70.3 (2.4)	64.9 (3.3)		69.6 (2.4)	61.2 (6.5)	
Education (%)	≤6th grade	59.2 (1.1)	64.9 (1.9)	<.001	60.3 (1.0)	52.2 (6.0)	0.467
	≥7th grade	38.6 (1.1)	25.9 (1.9)		36.7 (1.3)	26.1 (4.8)	
	Missing	2.3 (0.3)	9.2 (1.3)		3.0 (0.3)	21.6 (4.9)	
Spouse (%)	None	26.4 (0.9)	37.2 (2.1)	<.001	28.0 (0.9)	35.4 (5.9)	0.183
	Have	73.0 (0.9)	62.0 (2.1)		71.4 (0.9)	63.6 (5.9)	
	Missing	0.6 (0.1)	0.8 (0.5)		0.6 (0.1)	1.0 (1.0)	
Economic status (%)	1Q	40.3 (1.1)	52.8 (2.2)	<.001	42.3 (1.0)	45.3 (5.5)	0.439
	2–4Q	57.8 (1.1)	44.8 (2.2)		55.7 (1.1)	50.4 (5.5)	
	Missing	1.9 (0.3)	2.4 (0.8)		1.9 (0.3)	4.3 (3.4)	
Smoking (%)	Non or ex- smoker	85.4 (0.7)	75.4 (2.0)	0.011	84.0 (0.6)	71.7 (5.3)	0.345
	Current smoker	12.1 (0.6)	15.1 (1.5)		12.7 (0.6)	7.0 (3.1)	
	Missing	2.5 (0.3)	9.5 (1.3)		3.3 (0.4)	21.3 (4.9)	
Drinking (%)	Non to moderated drinker	94.8 (0.4)	95.0 (0.9)	0.898	94.8 (0.4)	97.2 (1.7)	0.297
	Heavy drinker	5.2 (0.4)	5.0 (0.9)		5.2 (0.4)	2.8 (1.7)	
Regular exercise (%)	None	82.3 (0.8)	77.3 (1.8)	0.449	81.8 (0.7)	64.8 (5.1)	0.536
	Have	15.2 (0.7)	13.0 (1.4)		14.8 (0.7)	13.8 (3.1)	
	Missing	2.6 (0.3)	9.7 (1.3)		3.4 (0.4)	21.3 (4.9)	
Stress (%)	None	76.7 (0.8)	70.4 (2.1)	0.738	76.0 (0.8)	593 (5.5)	0.522
	Have	20.8 (0.7)	19.9 (1.7)		20.7 (0.7)	19.4 (4.4)	
	Missing	2.5 (0.3)	3.7 (1.3)		3.3 (0.4)	21.3 (4.9)	
Depression (%)	None	82.2 (0.7)	76.2 (1.8)	0.967	81.5 (0.6)	65.5 (5.4)	0.823
	Have	15.4 (0.6)	14.3 (1.4)		15.2 (0.6)	13.2 (3.6)	
	Missing	2.5 (0.3)	9.5 (1.3)		3.3 (0.4)	21.3 (4.9)	
Suicidal ideation (%)	None	79.6 (0.8)	66.9 (2.2)	<.001	77.7 (0.8)	64.3 (5.3)	0.737
	Have	17.9 (0.8)	23.5 (1.8)		19.0 (0.7)	14.3 (3.2)	
	Missing	2.5 (0.3)	9.7 (1.3)		3.3 (0.4)	21.3 (4.9)	
Fall experience (%)	None	96.1 (0.4)	95.5 (0.9)	0.528	96.0 (0.3)	97.4 (1.8)	0.524
	Have	3.9 (0.4)	4.5 (0.9)		4.0 (0.3)	2.6 (1.8)	
Tinnitus (%)	None	71.6 (0.9)	55.2 (2.1)	<.001	69.4 (0.9)	48.1 (5.9)	<.001
	Have	28.2 (0.9)	44.2 (2.1)		30.4 (0.8)	51.9 (5.9)	
	Missing	0.2 (0.1)	0.6 (0.3)		0.3 (0.1)	-	
Dizziness (%)	None	80.9 (1.0)	73.7 (2.0)	<.001	79.7 (1.0)	77.3 (5.2)	0.627
	Have	19.1 (1.0)	26.3 (2.0)		20.3 (1.0)	22.7 (5.2)	
Obesity (%)	None	62.7 (1.0)	72.5 (1.8)	<.001	64.1 (0.9)	72.1 (5.1)	0.150
	Have	37.1 (1.0)	27.5 (1.8)		35.7 (0.9)	27.9 (5.1)	
	Missing	0.2 (0.1)	-		0.2 (0.1)	-	
Hypertension (%)	None	39.7 (1.0)	32.4 (2.0)	0.038	38.7 (0.9)	29.1 (5.3)	0.649
	Have	58.3 (1.0)	58.8 (2.0)		58.6 (0.9)	49.9 (6.0)	
	Missing	2.0 (0.3)	8.7 (1.3)		2.7 (0.3)	21.0 (4.9)	
Diabetes (%)	None	70.4 (0.8)	62.3 (1.9)	0.181	69.3 (0.8)	58.5 (5.6)	0.940
	Have	17.8 (0.6)	18.4(1.6)		18.0 (0.6)	14.8 (4.0)	
	Missing	11.8 (0.7)	19.3 (1.6)		12.8 (0.7)	26.7 (5.1)	
Occupational noise exposure (%)	None	89.3 (0.7)	84.0 (1.7)	0.001	88.6 (0.7)	79.9 (5.1)	0.030
	Have	10.7 (0.7)	15.7 (1.7)		11.3 (0.7)	20.1 (5.1)	
	Missing	-	0.2 (0.2)		0.1 (0.0)	-	
Leisure noise exposure (%)	None	98.2 (0.2)	98.1 (0.7)	0.825	98.2 (0.2)	99.2 (0.6)	0.324
	Have	1.7 (0.2)	1.5 (0.6)		1.7 (0.2)	0.8 (0.6)	
	Missing	0.1 (0.0)	0.4 (0.3)		0.2 (0.1)	-	
Firearm use (%)	None	77.0 (1.2)	72.9 (2.4)	0.051	76.3 (1.2)	77.3 (5.3)	0.853
	Have	23.0 (1.2)	26.9 (2.4)		23.7 (1.2)	22.7 (5.3)	
	Missing	-	0.2 (0.2)		0.1 (0.0)	-	

*Hearing loss is defined by the speech frequency PTA in the better ear with a 40 dB threshold/**.Many of the variables' classifications do not sum to 100% because of missing data.

Characteristics of the hearing loss and hearing-aid-use groups

The general characteristics of the hearing loss group and hearing-aid-use group are presented in Table 2. Compared to the group without hearing loss, the hearing loss group showed significant differences on the characteristics that they exhibited older age, higher proportion of males, urban residents, less education, spouse, lower economic status, current smokers, suicidal thoughts, tinnitus, dizziness, obesity, and occupational noise exposure.

Factors associated with hearing loss and hearing aid use

As presented in Table 3, the age-adjusted logistic regression analyses revealed that the odds of hearing loss were significantly associated with male sex, current smoker, suicidal ideation, tinnitus, dizziness, obesity, and occupational noise exposure. In the multivariate model, adjusted for all potential confounders, the odds of hearing loss were significantly associated with male sex, tinnitus, dizziness, and occupational noise exposure. The age-adjusted logistic regression analyses revealed that the odds of hearing aid use were significantly associated with male sex, tinnitus, and occupational noise exposure. In the multivariate model, adjusted for all potential confounders, the odds of hearing aid use were significantly associated with tinnitus and occupational noise exposure.

Table 3: Age-adjusted and multivariate-adjusted odds ratios of the hearing loss group and hearing aid use group by related variables (n = 5,447)

	Hearing loss *				Hearing aid use *			
	Age adjusted model		Multivariate model		Age adjusted model		Multivariate model	
	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value	OR (95% CI)	*P*-value
Sex (male)	1.68 (1.39–2.03)	<.001	1.65 (1.27–2.15)	<.001	1.84 (1.17–2.91)	0.009	0.65 (0.37–1.14)	0.139
Living place (urban)	0.95 (0.76–1.19)	0.679			0.80 (0.48–1.34)	0.411		
Education (≤ 6th grade)	0.89 (0.72–1.10)	0.302			1.12 (0.66–1.92)	0.657		
Spouse (yes)	1.08 (0.87–1.34)	0.459			1.19 (0.69–2.04)	0.525		
Economic status (Q1)	1.08 (0.89–1.32)	0.398			0.79 (0.50–1.24)	0.320		
Smoking (current)	1.69 (1.29–2.21)	0.001	1.33 (0.99–1.80)	0.056	0.71 (0.27–1.82)	0.480		
Drinking (heavy)	1.44 (0.95–2.19)	0.081	1.19 (0.77–1.86)	0.425	0.72 (0.21–2.47)	0.611		
Regular exercise (yes)	1.12 (0.87–1.45)	0.349			1.39 (0.82–2.38)	0.218		
Stress (yes)	1.02 (0.79–1.31)	0.868			1.19 (0.67–2.09)	0.545		
Depression (yes)	0.93 (0.72–1.19)	0.580			1.02 (0.53–1.95)	0.947		
Suicidal ideation (yes)	1.28 (1.01–1.62)	0.037	1.26 (0.98–1.61)	0.064	0.76 (0.44–1.31)	0.340		
Fall experience (yes)	0.80 (0.48–1.33)	0.397			0.46 (0.11–1.90)	0.285		
Tinnitus (yes)	1.94 (1.62–2.32)	<.001	1.91 (1.58–2.32)	<.001	2.28 (1.43–3.65)	0.001	2.35 (1.34–4.13)	0.003
Dizziness (yes)	1.34 (1.07–1.68)	0.010	1.35 (1.05–1.73)	0.017	1.02 (0.57–1.83)	0.934		
Obesity (yes)	0.77 (0.63–0.94)	0.010	0.86 (0.70–1.05)	0.147	0.83 (0.50–1.38)	0.488		
Hypertension (yes)	1.04 (0.84–1.28)	0.688			0.99 (0.57–1.72)	0.974		
Diabetes (yes)	1.07 (0.86–1.33)	0.494			0.91 (0.47–1.74)	0.782		
Occupational noise exposure (yes)	2.15 (1.63–2.85)	<.001	1.78 (1.32–2.38)	<.001	2.47 (1.31–4.67)	0.005	2.25 (1.01–5.02)	0.047
Leisure noise exposure (yes)	1.36 (0.56–3.32)	0.490			0.68 (0.15–2.94)	0.607		
Firearm use (yes)	1.19 (0.95–1.49)	0.112	0.83 (0.62–1.11)	0.211	0.90 (0.50–1.62)	0.744		

* Hearing loss is defined by the speech frequency PTA in the better ear with a 40 dB threshold.

Discussion

The prevalence of hearing loss in South Korean elders aged 60 and older was 16.8% according to the WHO's hearing impairment criteria. This figure appears higher than the hearing loss prevalence of US elders aged 70 and older (16.5%) (1) and Finnish elders aged 70 and older (15.2%) (35), when the age gap of the sample was adjusted. Race has been reported as a strong, consistent, and non-modifiable risk factor for hearing loss (3, 6), but the mechanisms underlying race differ-

ences in hearing function are not well understood (36). Most studies have examined the gap between Caucasians and African-Americans, but studies on Asians have been scarce (37, 38). A follow-up study is necessary to identify race-specific hearing loss mechanisms in Asians. This study found that the prevalence of mild and more serious cases of hearing loss was 49.2%, indicating that 1 of every 2 South Koreans aged 60 and older have hearing loss or a slight impairment at the least. In this investigation, 37.7% of the elders claiming to have no hearing problem had a mild or more serious case of hearing loss, and 14.5% claiming to have a hearing problem had normal hearing. In a previous study (38), self-reported disability was underrated by the elders with mild impairment, and there was a low correlation between self-reported hearing loss and the results of the audiometric test, which was consistent with this study's findings. Although standardized audiometric assessments of hearing loss may be considered the gold standard for estimating its prevalence, large studies often are constrained by limited budgets, expertise, and the logistics of performing audiometric screening on a large scale (2). Self-reports by elders about their hearing loss requires careful evaluation.

Despite having a hearing impairment, the elders did not perceive it as a problem and tended to underestimate its seriousness. Therefore, they might have delayed the start of using a hearing aid. Only 15.9% of the participants aged 60 and older with at least a moderate hearing loss used a hearing aid whereas, the overall prevalence of hearing aid use of 5 hours or more per week in US elders aged 70 and older was 19.1% (1). Although elders' hearing loss rates sharply increase with age, the 60–64 age group used more hearing aids than any other age group. This finding was inconsistent with previous studies reporting that age is a predictor of hearing aid use (1, 9, 19, 23). As the South Korean elders reduce their social activities and communication opportunities, and experience more serious health problems than hearing loss, they tend to disregard their hearing problem (25, 26). Hearing loss in the elders often is regarded as natural, thus, people fail to understand the advantages of wearing a hearing aid, and this study found a lower use of them than did previous studies. Hearing aid use by elders is low due to financial issues, although elders realize their importance. Social assistance has been extended for financial problems, but government assistance remains insufficient (25). Elders with hearing loss had a significantly lower academic background and poorer economic status, and socioeconomic status has been found to affect elders' hearing loss and hearing aid use (1, 6, 9). However, there was no significant correlation between hearing aid use and socioeconomic status. This finding is possibly because of the national free hearing aid supply project for elders in the lower income bracket that helps them acquire hearing aids free of charge, while the hearing aid use of the entire country is already low.

After multivariate adjustment, sex, (non-modifiable risk factor for hearing loss), was associated with higher rates of hearing loss, which is consistent with other studies (1, 6). Hypertension, diabetes, drinking, and regular exercise revealed no significant association with hearing loss similar to other studies that reported inconsistent correlations (1, 3, 6). These results might be because cardiovascular risk factors are weakly associated with hearing loss, and their effects may be masked by stronger risk factors (e.g., age), particularly in cohorts consisting of elders (1). Current smokers showed higher ORs of hearing loss, which might be due to reduced cochlear blood flow or because of the ototoxic effects of nicotine on cochlear hair cells (39). Therefore, smoking status and grade changes in hearing loss according to specific amounts of smoking should be studied. Tinnitus, a debilitating condition for many sufferers, had the largest OR associated with the elders' hearing loss. Its prevalence increases with age and often coexists with hearing loss (40). Although the majority of those affected by hearing loss, tinnitus, and dizziness are elders, the underlying pathology of the three conditions remains the same across age groups (41, 42). Elders with serious hearing loss experience tinnitus and dizziness together (42). Tinnitus and occupational noise exposure had the strongest associations with hearing aid use after multivariate adjustment and their effects on

elders' hearing loss were consistent with the findings of other studies (1, 3, 6). However, the outcomes for leisure noise exposure were not statistically significant and this is likely an underestimate. In summary, our results suggest that hearing loss has a high prevalence among Korean elders and that the non-modifiable risk factors of age and sex are its strongest determinants.

The present study has several limitations. First, approximately 18% of older adults who had the health examination did not complete the audiometric assessment, and they were older. Therefore, the true prevalence of hearing loss in Korea might have been underestimated. Second, the data on the variables examined in the health interview survey consisted of self-reports, focusing on subjective opinions, which may have reduced their accuracy. Third, the study's cross-sectional design makes it difficult to determine a causal relationship between risk factors, hearing loss, and other variables. A longitudinal study might confirm causal relationships. Finally, when interpreting the results, the high proportion of missing data should be noted.

Conclusion

This study found that 16.5% of Korean elders had moderate or serious hearing loss and only 15.9% used a hearing aid. This study is significant because it analyzed data from a health examination of a national sample of Korean elders, thereby ensuring the representativeness of the sample. An aural rehabilitative program should address non-modifiable and modifiable risk factors associated with hearing loss in the elderly.

Ethical considerations

Ethical issues regarding plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancy have been completely observed by the author.

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