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Discrepancies between self-reported hearing difficulty and hearing loss diagnosed by audiometry: prevalence and associated factors in a national survey

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ABSTRACT

Objective To evaluate discrepancies prevalent between self-reported hearing difficulty (SHD) and audiometrically measured hearing loss (AHL) and factors associated with such discrepancies.

Design Nationwide cross-sectional survey.

Setting Data from 2010 to 2012 Korea National Health and Nutrition Examination Survey conducted by the Korea Centers for Disease Control and Prevention.

Participants We included 14 345 participants aged ≥19 years who had normal tympanic membranes (mean age of 49 years).

Measures Self-reported hearing was assessed by asking participants whether they had difficulty in hearing. AHL was defined as >25 dB of mean hearing thresholds measured at 0.5, 1, 2 and 4 kHz in better ear. Underestimated hearing impairment (HI) was defined as having AHL without SHD. Likewise, overestimated HI was defined as having SHD without AHL. Prevalence of underestimated and overestimated HIs was determined. Univariable and multivariable analyses were performed to examine factors associated with such discrepancies compared with concordant HL.

Results Among 14 345 participants, 1876 (13.1%) had underestimated HI while 733 (5.1%) had overestimated HI. Multivariable models revealed that participants who had discrepancies between SHD and AHL were less likely to have older age (OR: 0.979, 95% CI: 0.967 to 0.991 for the underestimated HI, OR: 0.905, 95% CI: 0.890 to 0.921 for the overestimated HI) and tinnitus (OR: 0.425, 95% CI: 0.344 to 0.525 for the underestimated HI and OR 0.523, 95% CI: 0.391 to 0.699 for the overestimated HI) compared with those who had concordant HI. Exposure to occupational noise (OR: 0.566, 95% CI: 0.423 to 0.758) was associated with underestimated HI, and medical history of hypertension (OR: 1.501, 95% CI: 1.061 to 2.123) and depression (OR: 1.771, 95% CI: 1.041 to 3.016) was associated with overestimated HI.

Conclusion Age, tinnitus, occupational noise exposure, hypertension and depression should be incorporated into evaluation of hearing loss in clinical practice.

Strengths and limitations of this study

- This study was based on a nationwide large-scale cross-sectional survey.
- We analysed only participants who had normal tympanic membranes to exclude participants who have undergone a previous hearing evaluation.
- We used definition of hearing loss as mean hearing threshold of >25 dB HL measured at 0.5, 1, 2 and 4 kHz in the better ear in accordance with the WHO definition (World Health Organization 2014).
- Multivariable logistic analysis was performed using both auditory and non-auditory factors including personal, socioeconomic, psychological and health-related factors.
- Because the survey did not assess the history of hearing evaluation for each participant, this might have influenced discrepancy between self-reported hearing and audiometry.

INTRODUCTION

Hearing is usually assessed in the clinic by using pure-tone audiometry to measure the smallest detectable level of pure tone at several frequencies, typically in the range of 0.5–8 kHz. Sometimes, the use of self-reported hearing measurements is attractive in occupational health screening programmes or a large-scale epidemiologic survey due to the costs and time constraints of audiometric measurements. However, discrepancies between self-reported hearing and pure-tone thresholds have been reported in multiple studies.[1–11] Therefore, it is necessary to understand prevalence of this discrepancy and various factors affecting the accuracy of self-reported hearing when using as a surrogate measurement of audiometry.

Previous studies have reported that accuracy of self-reported hearing difficulty (SHD) is associated with auditory factors (eg,

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degree of hearing loss, frequencies of hearing loss and middle ear infection)[5–7 9 10 12 13] as well as demographic factors.[3 5 7 14 15] However, these studies have mainly focused on elderly populations[3 8 11 14] or SHD with normal audiogram.[1 7] Few studies have focused on the non-auditory factors (socioeconomic factors, psychological factors, healthcare utilisation or other personal information) that might influence the self-reported hearing assessment in a large population of various ages. Although a study has recently reported discrepancy between self-reported hearing and audiometry,[5] this study included participants with abnormal tympanic membrane (TM) findings such as perforation, cholesteatoma or effusion. Because individuals who have abnormal TM are more likely to have undergone a previous hearing evaluation, this might have influenced self-reported hearing and also discrepancy from audiometry.

The primary aim of this study was to evaluate the prevalence of discrepancy between SHD and audiometrically measured hearing loss (AHL) in terms of overestimation or underestimation in a population with normal TMs based on national survey data. We also comprehensively investigated whether non-auditory metrics such as socioeconomic factors, psychological factors, medical history, healthcare utilisation and other personal information could affect the accuracy of SHD and types of discrepancy.

METHODS

Data source

This study used data from the fifth Korea National Health and Nutrition Examination Survey (KNHANES). The KNHANES is a nationwide cross-sectional survey conducted annually by the Korea Centers for Disease Control and Prevention (KCDC) to investigate health and nutritional status of a representative Korean population.[16] Every year, about 10 000 individuals in 3840 households are selected from a panel to represent the population through a multistage clustered and stratified random sampling method based on National Census Data. A total of 576 survey areas were drawn from the population and housing census by considering the proportion of each subgroup. The participation rate of selected households was about 80%. The survey manuals and microdata of KNHANES are available in public through the official website of KNHANES (http://knhanes.cdc.go.kr).

Study population

From 2010 to 2012, a total of 23 621 individuals (8313 in 2010, 7887 in 2011 and 7421 in 2012) agreed to participate in health surveys. Among participants >19 years of age, we included participants who completed hearing questionnaire, audiometric measurement and examination of TMs. As individuals with abnormal TM are more likely to have correct information on their hearing status from the prior hearing tests, we excluded participants with abnormal TM, and whose information on outcome variables was missing.

Hearing questionnaire and audiometric measurement

Participants were first asked about their perceived HD. In detail, participants were asked to rate their difficulty in hearing with a survey question: 'Which sentence best describes your hearing status (while not using hearing aids)?', and to choose an answer for the question: (1) 'Don't feel difficulty at all,' (2) 'A little bit difficult', (3) 'Very difficult' and (4) 'Can't hear at all'. SHD was indicated when the response was (2) , (3) or (4).

Pure tone air-conduction threshold was measured in a double-walled sound booth (CD-600, Sontek, Paju, South Korea) using an audiometer (SA-203, Entomed AB, Malmö, Sweden). A TDH39P Phone type headphone (10 Ohm) was used. Calibration of the audiometer was carried out annually according to the user's manual. The ambient noise level measured inside the booth under maximal noisy conditions in the survey unit met the ISO 8253–1 standard. Otolaryngologists who had been trained to operate the audiometer provided instructions to participants and obtained audiometric data. Air conduction thresholds were measured at 0.5, 1, 2, 3, 4 and 6 kHz in accordance with the American National Standards Institute standard.[17]

Hearing loss (HL) in this study was defined as the mean air conduction hearing thresholds >25 dB HL at 0.5, 1, 2 and 4 kHz in the better ear. Discrepancy between self-reported hearing and audiometry was classified in terms of underestimated and overestimated hearing impairment (HI). Underestimation of HI was defined as having AHL without SHD. Likewise, overestimation of HI was defined as having SHD without AHL. Concordant HI was defined as having both AHL and SHD.

Otologic examination and questionnaires

An ear examination was conducted with a 4 mm 0°-angled rigid endoscope attached to a Charge-Coupled Device camera by trained otolaryngologists. Endoscopic examination was performed to identify abnormal TM findings such as perforation, cholesteatoma (including retraction pocket) and otitis media with effusion (including the presence of a ventilation tube). Trained otolaryngologists categorised both TMs into the following three groups: normal, abnormal and could not examine. Only participants with normal TMs on both sides were included in this study.

Participants were asked about their tinnitus experiences using the following question: 'During the past year, did you ever hear a sound (buzzing, hissing, ringing, humming, roaring, machinery noise) originating in your ear?'. Examiners were instructed to record either 'yes' or 'no'. If a participant reported that they heard an odd or unusual noise at any time in past years, examiners recorded 'yes'. Participants were also asked about their experience with occupational noise exposure. They were instructed to record either 'yes' or 'no' for the question

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'Have you ever worked more than 3 months in the place where you have to speak loudly to communicate with others because of noisy sound?'

Outcome variables

Age, sex, smoking status, alcohol consumption, marital status, waist circumference (cm) and body mass index (kg/m^2) of each participant were collected and categorised as personal factors in this study. Smoking status was divided into three groups: never smoked, past smoker and current smoker. The participants were asked to self-report to question 'Do you smoke now?'. If the participant smoked in the past but did not smoke now, it was classified as a past smoker. Alcohol consumption was divided into two groups according to their drinking frequency during the last year: non-drinker and drinker. The question was 'How often do you drink alcohol in the last year?'. The participants who had never drunk at all during the last year were classified as non-drinker, while others were classified as drinker.

A non-drinker was defined as a participant who had never drunk during the last year. Marital status was divided into two groups through the questionnaire: ever married and never married. The marital status question was 'Have you been married?'. Ever married included participants married at the time of survey, separated, widowed or divorced.

To evaluate socioeconomic factors, monthly income, education level and employment status were assessed. Participants answered an open-ended question on income: 'What is your average monthly income including salaries, property income, pension, government subsidies and allowance?'. Monthly income indicates equalised monthly household income and was calculated by dividing total family income by the square root of the number of household members. Monthly income was classified into quartiles to determine monthly income level: lower, lower middle, upper middle and upper. With regard to educational level, the participants were asked the level at which their education was completed, which was classified into four educational categories: completion of elementary school, middle school, high school and post-secondary school. Education level was re-divided into two groups: less than high school and high school or more. Employment status was divided into employed and unemployed groups. The participants answered either 'yes' or 'no' to the question 'Have you ever worked more than 1 hour for the last week for income, or worked as unpaid family worker for over 18 hours? (The temporary leave status is also included if you have worked.)'

Quality of life was measured using Euro Qol-5D (EQ-5D) consisting of a health-status descriptive system (EQ-5D) and a visual analogue scale (EQ-VAS). EQ-5D is a standard tool used to measure patient's health status in the following five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression.[18 19] Each dimension has three grades of severity: no problem (score of 1), moderate problem (score of 2) or serious problem (score of 3). EQ-5D index is calculated from EQ-5D score by applying a formula that assigns weights to each grade in each dimension. This formula differs among nations because it is based on the value of EQ-5D of the population.[20] KNHANES algorithm was used to calculate the EQ-5D index in the present study. The EQ-5D index ranged from 1 (best health) to 0 (equivalent to death) or −0.171 (worse than death). Next, participants described their own health status using a VAS ranging from 0 (worst imaginable health) to 100 (best imaginable health) presented as EQ-VAS.

To evaluate psychological factors, self-reported health status and body shape perception were assessed. Self-reported health status was categorised into three answers: good, fair and poor. The question was 'What do you usually think about your health?'. Participants were asked to report their body shape perception as 'too thin', 'just right' or 'too fat'. The question was 'What do you think of your body weight status?'. Self-reported stress and depression levels were also assessed. Participants were asked about their stress level using the following question 'How much do you feel stress in ordinary life?'. They were instructed to report one of the following responses to the question: 'extremely stressed', 'quite stressed', 'a little bit stressed' and 'not stressed at all'. The responses were re-categorised into 'low level (not stressed at all or a little bit stressed)' or 'high level (extremely or quite stressed)'. To assess the self-perceived level of depression, participants answered either 'yes' or 'no' to the question 'Have you felt sorrow or despair that has affected your daily life for more than 2 weeks continuously during the past year?'

To evaluate health-related factors, physical activity, the use of medical service and current disease were assessed. The intensity of the physical activity was categorised as vigorous, moderate and light. Examples of vigorous intensity physical activities were soccer, basketball, aerobics, running, fast cycling and fast swimming. Moderate physical activities included cycling at a regular pace, swimming at a regular pace, slow swimming, noncompetitive volley ball and doubles tennis. Walking slowly or at a moderate pace for the use of public transportation were included in the light physical activity. We used the guidelines suggested by Noh *et al*[21] to divide the participants into exercising and non-exercising groups based on the number of days and hours in which they took part in physical activity. The intensity of the physical activity was based on the physical activity recommendations of the Centers for Disease Control and Prevention and the American College of Sports Medicine. These activities were categorised as follows: those who perform vigorous-intensity activity for a minimum of 20 min at least 3 days each week; those who perform moderate-intensity physical activity for a minimum of 30 min at least 5 days each week and those who perform light-intensity activity for a minimum of 30 min for at least 5 days weekly. Individuals who did not exercise regularly were placed into the non-exercising group. Medical services evaluated restriction of medical service, health screening and medical history.

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The participants were asked to answer either 'yes' or 'no' about the restricted use of medical service. The question was 'Have you ever been unable to go to the clinic (except for dentistry) during the past year?'. To assess the health screening status, the participants answered either 'yes' or 'no' to the question 'Have you ever had a health checkup for health during the last two years?' Participants were also asked about their current disease diagnosed by a medical doctor. They answered either 'yes' or 'no' to questions about current disease. Among the various disease lists, histories of hearing-related diseases such as obesity, hypertension, myocardial infarction, angina, asthma, depression, renal failure and diabetes mellitus were selected as variables.[22 23]

According to the standard protocol, systolic blood pressure (BP) and diastolic BP were measured by trained nurses using a mercury sphygmomanometer (Baumanometer Desk model; Baum, Amherst, New York, USA) on the right arm of the subject while sitting after taking at least 5 min of rest. BP was measured three times and the second and third measurements were averaged. Blood and urine samples were collected in the morning after fasting for at least 8 hours. Fasting blood samples and spot urine samples were processed, refrigerated immediately, and transported in cold storage to a central laboratory (Neodin Medical Institute, Seoul, Korea). All samples were analysed within 24 hours after transportation. Total cholesterol, high-density lipoprotein (HDL) cholesterol, triglyceride, haemoglobin, haematocrit, blood urea nitrogen and serum creatinine levels were measured with a Hitachi Automatic Analyzer 7600 (Hitachi, Tokyo, Japan). Urine protein and glucose levels were measured using a dipstick in a spot urine sample.

Statistical analysis

All statistical analyses were performed by taking account of weights from a complex sampling design according to the guideline for analysis of KNHANES data. The KCDC has published guideline for analysis through the official website of KNHANES (http://knhanes.cdc.go.kr). The survey design created a sample weight assigned to each sample individual through the following three steps so that the total sample would represent the population (on average) for 2010–2012 period: calculating the base weight of the inverse of the final probability an individual being selected, adjusting for non-response and post-stratification adjustment to match previous census population control totals. Weights in 2010, 2011, 2012 surveys were combined, and the average weight (sum of weight for each year/3) was calculated. Statistical analyses were performed using SAS V.9.4 (SAS Institute).

Logistic regression or linear regression was used to evaluate factors associated with discrepancies between SHL and AHL. Variables found to have possible association in univariable analysis ($p<0.20$) were entered into the multivariable analysis model. Serologicaldata were not entered into the multivariable analysis model due to a significant number of missing data. In this study, the population group was classified into three categories: participants who had overestimated HI, underestimated HI and concordant HI. To evaluate factors associated with underestimated HI, we compared participants with underestimated HI and concordant HI. We also compared participants with overestimated HI and concordant HI to evaluate factors associated with overestimated HI. The p values were obtained two-sided. Bonferroni's correction was applied to the p value and the corresponding CI due to multiple testing. Statistical significance was considered when adjusted p value was less than 0.05.

Patient and public involvement

Participants and the public were neither involved in designing the study or developing the research questions, nor were they involved in analysing or interpreting the findings. There are no plans for the study results to be disseminated directly to participants.

RESULTS

Basic characteristics of study population

A total of 25 094 Korean citizens participated in the KNHANES from 2010 to 2012. Of them, 16 727 participants aged ≥19 years completed the hearing questionnaire and audiometric measurement. After excluding participants with abnormal TM and missing data, a total of 14 345 participants were ultimately eligible for this study. The mean ±SD age of the study population was 49.2±16.1 years (ranged from 19 to 97). The study population consisted of 42.5% males and 57.5% females.

Prevalence of discrepancies between self-reported hearing and audiometry

Of the 14 345 participants with normal TMs, 3001 (20.9%) participants had AHL and 1858 (13.0%) had SHD. Table 1 shows the percentage and prevalence of discrepancies between self-reported hearing and audiometry. Of the 3001 participants with AHL, 62.5% (n=1876) reported no SHD. On the other hand, 733 (39.5%) of 1858 participants with SHD had no AHL (mean audiometric thresholds ≤25 dB HL in the better ear). That is, the prevalence of underestimated and overestimated HI was 62.5% and 39.5%, respectively. The prevalence of discrepancies between self-reported hearing and audiometry was 18.2% (n=2.609).

Factors associated with underestimated hearing impairment

A total of 3001 participants who had bilateral HL (mean hearing thresholds >25 dB HL at 0.5, 1, 2 and 4 kHz) were analysed to evaluate factors associated with underestimated HI using linear and logistic regression analyses. Results are shown in table 2. In univariable analyses, age, alcohol consumption, education, employment status, quality of life, self-reported health status, depressive mood, restricted use of medical service, hospital visit, history of myocardial infarction, angina, asthma, tinnitus, occupational noise exposure, diastolic BP and

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Table 1 Percentage and prevalence rates of discrepancy between self-reported hearing and audiometry

Audiometry \ Questionnaire	Hearing difficulty	No difficulty	Total
Hearing loss	1125 (A)	1876 (B)	3001 (A+B)
Normal	733 (C)	10611 (D)	11344 (C+D)
Total	1858 (A+C)	12 487 (B+D)	14345 (A+B+C+D)

Percentage of discrepancy (%)=18.2% [(B+C) / (A+B+C+D)].
Underestimation of hearing impairment=62.5% [B / (A+B)].
Overestimation of hearing impairment=39.5% [C / (A+C)].

blood urea nitrogen were significantly associated with underestimated HI. In multivariable analysis, participants who underestimated HI showed significantly decreased age (OR: 0.979, 95% CI: 0.967 to 0.991) compared with those who had both AHL and SHD. Also, participants who underestimated HI were less likely to have tinnitus (OR: 0.425, 95% CI: 0.344 to 0.525) or exposure to occupational noise (OR: 0.566, 95% CI: 0.423 to 0.758) compared with those who showed concordant HI.

Associated factors with overestimated hearing impairment

A total of 1858 participants who had SHD were analysed to investigate factors associated with overestimated HI. Results of univariable and multivariable analyses are shown in table 3. In univariable analysis, age, sex, smoking, alcohol consumption, waist circumference, monthly income, marital status, education level and employment status were significantly associated with overestimated HI compared with those who had both SHD and AHL. For quality of life factors, EQ-5D subscales such as physical activity about mobility, self-care, and usual activity, EQ-5D index and EQ-VAS were significantly associated with overestimated HI. For psychologic factors, self-reported health status, body shape perception and amount of stress in life were significantly associated with overestimation of HI. Overestimation of HI was also significantly associated with vigorous and moderate physical activity, hospital visit and history of hypertension, angina, depression, diabetes mellitus and tinnitus. Systolic BP, HDL cholesterol, blood urea nitrogen and serum creatinine levels were also significantly associated with overestimated HI. In multivariable analysis, participants who overestimated HI showed significantly decreased age (OR: 0.905, 95% CI: 0.890 to 0.921) compared with those who had concordant HI. Participants who overestimated HI were more likely to have hypertension (OR: 1.501, 95% CI: 1.061 to 2.123) and depression (OR: 1.772, 95% CI: 1.041 to 3.016) but less likely to report tinnitus (OR 0.523, 95% CI: 0.391 to 0.699) compared with those who had both SHD and AHL.

DISCUSSION

This cross-sectional survey of Korean population aged ≥19 years found that 18.2% of participants had a discrepancy between their SHD and AHL. Most (71.9%) of these participants had AHL but no SHD (underestimated HI) while the rest (28.1%) had SHD but no AHL (overestimated HI, table 1). The accuracy of hearing assessments in the present study (81.8%) was higher than that reported in elderly population of USA (71.8%),[3] but similar to that reported in the general population of Australia (82%).[6] Previously, Kim *et al*[5] categorised the self-reported hearing into three categories (no difficulty, a little difficulty and much difficulty) and classified the mean pure-tone threshold of the better ear into three groups (<25 dB, ≥25 dB and <40 dB, and ≥40 dB). When the participants of previous study[5] were reclassified as in our study, the accuracy of hearing assessments was slightly higher (83.2%) than our result. In addition, our result showed that 5.1% (733 of 14 325) of participants reported overestimated HI and 13.1% (1876 of 14 325) reported underestimated HI. However, reclassified results in Kim *et al* showed that 6.3% (1237 of 19 642) of participants reported overestimated HI and 10.5% (2059 of 19 642) of participants reported underestimated HI. Although present study and Kim *et al* analysed using same dataset, participants with abnormal TMs were excluded in our study, but included in Kim *et al*. Thus, differences in prevalence can be explained by the fact that individuals who have abnormal TM are more likely to report SHD and are more likely to have undergone a previous hearing evaluation.

Our results showed that both non-auditory factors (demographic factors and medical histories) and auditory factors (tinnitus and occupational noise exposure) were associated with discrepancy between self-reported hearing and audiometry in multivariable analysis. For demographic factors, participants who underestimated or overestimated their HI were significantly younger compared with participants who had concordant HI (tables 2 and 3). It is well known that audiometric HL dramatically increases with increasing age.[23] SHD is also increased with age as difficulty of speech understanding in adverse listening conditions increases[24] due to decreased synaptic loss,[25] working memory capacity[26 27] or impaired temporal processing.[12 28] Our reference group was defined as participants who had both SHD and AHL (concordant HI), so it is highly likely that older participants will have both SHD and AHL. Therefore, it is not surprising that younger participants were less likely to have SHD among participants with audiometric HL (table 2) and had fewer

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Table 2 Univariable and multivariable analyses of factors associated with underestimated hearing impairment

Variables	Total population with AHL		Underestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Personal factor										
Age (years)	4 660 594	62.0†	3 023 386	64.9	0.977	0.968 to 0.986	**<0.0001**	0.979	0.967 to 0.991	**0.001**
Sex										
Male	2 594 824	55.7	1 702 933	65.6	1.078	0.897 to 1.295	0.425			
Female	2 065 770	44.3	1 320 453	63.9	Referent					
Smoke										
Never	2 165 731	46.5	1 385 246	64.0	Referent					
Past smoker§	1 369 414	29.4	883 557	64.5	1.025	0.804 to 1.306	1.000			
Current smoker§	1 125 449	24.1	754 583	67.0	1.146	0.850 to 1.546	1.227			
Drinking alcohol in past year										
Non-drinker	1 666 794	35.8	1 012 283	60.7	Referent					
Drinker	2 993 800	64.2	2 011 103	67.2	1.323	1.102 to 1.589	**0.003**	1.025	0.831 to 1.266	0.814
Marital status										
Ever married	4 518 752	97.0	2 917 820	64.6	0.626	0.289 to 1.360	0.236			
Never married	141 843	3.0	105 566	74.4	Referent					
Waist circumference (cm)	4 660 594	84.0†	3 023 386	64.9	0.998	0.988 to 1.008	0.668			
Body mass index (kg/m^2)	4 660 594	24.0†	3 023 386	64.9	1.012	0.982 to 1.042	0.447			
Socioeconomic factors										
Income										
Lower	1 579 965	33.9	964 575	61.1	Referent					
Lower middle§	1 296 182	27.8	833 271	64.3	1.148	0.853 to 1.547	0.800	0.806	0.585 to 1.111	0.324
Upper middle§	934 922	20.1	641 226	68.6	1.393	0.994 to 1.952	0.057	0.949	0.659 to 1.366	1.000
Upper§	849 526	18.2	584 315	68.8	1.406	0.999 to 1.978	0.052	0.963	0.651 to 1.427	1.000
Education										
Less than high school	2 883 779	61.9	1 789 349	62.0	Referent					
High school or more	1 776 815	38.1	1 234 038	69.5	1.391	1.134 to 1.704	**0.002**	1.087	0.853 to 1.386	0.498
Employment status										
Employed	2 566 437	55.1	1 730 554	67.4	1.283	1.066 to 1.545	**0.009**	0.966	0.777 to 1.202	0.757
Unemployed	2 094 158	44.9	1 292 832	61.7	Referent					
Quality of life										

Continued

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Table 2 Continued

Variables	Total population with AHL		Underestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
EQ-5D (%)										
Physical activity (mobility)										
Normal	3 310 530	71.0	2 252 247	68.0	Referent					
Limited	1 350 065	29.0	771 140	57.1	0.626	0.516 to 0.759	**<0.0001**			
Physical activity (self-care)										
Normal	4 249 662	91.2	2 790 703	65.7	Referent					
Limited	410 932	8.8	232 683	56.6	0.682	0.509 to 0.915	**0.011**			
Physical activity (usual activities)										
Normal	3 832 356	82.2	2 562 274	66.9	Referent					
Limited	828 238	17.8	461 112	55.7	0.623	0.497 to 0.780	**<0.0001**			
Physical activity (pain/discomfort)										
Normal	3 243 388	69.6	2 167 417	66.8	Referent					
Limited	1 417 206	30.4	855 969	60.4	0.757	0.622 to 0.922	**0.006**			
Physical activity (anxiety/depression)										
Normal	4 020 865	86.3	2 651 467	65.9	Referent					
Limited	639 729	13.7	371 919	58.1	0.717	0.554 to 0.929	**0.012**			
EQ-5D index (%)										
Index<0.75	560 616	12.0	316 793	56.5	Referent					
0.75≤index < 1.00§	1 479 603	31.7	885 908	59.9	1.148	0.841 to 1.568	0.638	0.841	0.584 to 1.210	0.573
Index=1.00§	2 620 375	56.2	1 820 686	69.5	1.752	1.275 to 2.408	**<0.0001**	0.930	0.606 to 1.426	1.000
EQ-VAS (0 to 100)	4 660 594	62.0†	3 023 386	64.9	1.008	1.003 to 1.012	**0.001**			
Psychological factors										
Perceived health status										
Good§	1 279 057	27.4	922 424	72.1	1.311	1.007 to 1.707	**0.043**	1.255	0.958 to 1.643	0.120
Average	2 077 480	44.6	1 378 474	66.4	Referent					
Bad§	1 304 058	28.0	722 488	55.4	0.630	0.492 to 0.806	**<0.0001**	0.79	0.588 to 1.061	0.148
Body shape perception										
Too thin§	981 355	21.1	617 482	62.9	0.914	0.697 to 1.707	0.456			
Just right	2 055 525	44.1	1 336 044	65.0	Referent					
Too fat§	1 623 715	34.8	1 069 861	65.9	1.040	0.814 to 1.330	0.719			

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Table 2 Continued

Variables	Total population with AHL		Underestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Stress level										
Low	3 556 134	76.3	2 350 397	66.1	Referent					
High	1 104 460	23.7	672 990	60.9	0.800	0.629 to 1.018	0.070	1.000	0.762 to 1.313	0.998
Depressive mood lasting for 2 weeks										
No	3 881 578	83.3	2 579 702	66.5	Referent					
Yes	779 016	16.7	443 684	57.0	0.668	0.513 to 0.868	**0.003**	0.795	0.576 to 1.097	0.162
Health-related factors										
Vigorous physical activity practice										
Non-exercising	4 150 544	89.1	2 680 694	64.6	Referent					
Exercising	510 050	10.9	342 693	67.2	1.123	0.822 to 1.534	0.467			
Moderate physical activity practice										
Non-exercising	4 306 908	92.4	2 791 890	64.8	Referent					
Exercising	353 687	7.6	231 496	65.5	1.028	0.733 to 1.442	0.873			
Light physical activity practice										
Non-exercising	2 957 617	63.5	1 912 833	64.7	Referent					
Exercising	1 702 977	36.5	1 110 554	65.2	1.024	0.841 to 1.247	0.814			
Restricted use of medical services										
Yes	864 993	18.6	492 523	56.9	0.661	0.516 to 0.847	**0.001**	0.802	0.608 to 1.059	0.120
No	3 795 601	81.4	2 530 863	66.7	Referent					
Health screening										
Yes	2 954 154	63.4	1 912 266	64.7	0.983	0.804 to 1.202	0.870			
No	1 706 441	36.6	1 111 120	65.1	Referent					
Hospital visit in past 2 weeks										
Yes	1 922 260	41.2	1 156 350	60.2	0.705	0.583 to 0.851	**0.0003**	0.896	0.727 to 1.104	0.301
No	2 738 335	58.8	1 867 037	68.2	Referent					
Hospitalisation in past year										
Yes	572 508	12.3	360 689	63.0	0.912	0.700 to 1.188	0.492			
No	4 088 086	87.7	2 662 698	65.1	Referent					
Obesity occurrence										
Underweight§	159 020	3.4	97 392	61.2	0.894	0.491 to 1.628	1.000			

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Table 2 Continued

Variables	Total population with AHL		Underestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Normal	2 881 216	61.8	1 840 506	63.9	Referent					
Overweight§	1 620 358	34.8	1 085 489	67.0	1.148	0.918 to 1.435	0.335			
Medical history										
Hypertension										
Yes	1 684 501	36.1	1 066 151	63.3	0.898	0.742 to 1.086	0.266			
No	2 976 094	63.9	1 957 235	65.8	Referent					
Myocardial infarction										
Yes	70 821	1.5	34 451	48.6	0.507	0.258 to 0.999	**0.050**	0.538	0.242 to 1.198	0.129
No	4 589 773	98.5	2 988 935	65.1	Referent					
Angina										
Yes	169 542	3.6	89 693	52.9	0.596	0.381 to 0.900	**0.024**	0.803	0.500 to 1.288	0.363
No	4 491 052	96.4	2 933 694	65.3	Referent					
Asthma										
Yes	192 575	4.1	101 638	52.8	0.591	0.389 to 0.899	**0.014**	0.765	0.498 to 1.175	0.221
No	4 468 019	95.9	2 921 748	65.4	Referent					
Depression										
Yes	202 039	4.3	130 770	64.7	0.993	0.663 to 1.487	0.974			
No	4 458 555	95.7	2 892 616	64.9	Referent					
Renal failure										
Yes	42 069	0.9	19 908	47.3	0.483	0.184 to 1.268	0.139	0.707	0.255 to 1.956	0.503
No	4 618 526	99.1	3 003 479	65.0	Referent					
Diabetes mellitus										
Yes	658 868	14.1	396 751	60.2	0.792	0.618 to 1.202	0.067	0.974	0.740 to 1.281	0.849
No	4 001 727	85.9	2 626 635	65.6	Referent					
Auditory factors										
Tinnitus										
No	3 040 249	65.2	2 205 518	72.5	Referent					
Yes	1 620 345	34.8	817 869	50.5	0.386	0.316 to 0.472	**<0.0001**	0.425	0.344 to 0.525	**<0.0001**
Occupational noise exposure										
Yes	800 620	17.2	459 993	57.5	0.683	0.520 to 0.897	**0.006**	0.566	0.423 to 0.758	**<0.0001**

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Table 2 Continued

Variables	Total population with AHL		Underestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
No	3 859 974	82.8	2 563 394	66.4	Referent					
Laboratory measures										
Systolic BP (mm Hg)	4 660 594	126.4†	3 023 386	64.9	1.001	0.996 to 1.007	0.573			
Diastolic BP (mm Hg)	4 660 594	77.0†	3 023 386	64.9	1.015	1.006 to 1.024	**0.002**	1.009	1.000 to 1.019	0.058
Total cholesterol (mg/dL)	4 394 622	191.7†	2 859 596	65.1	1.001	0.998 to 1.003	0.683			
HDL cholesterol (mg/dL)	4 394 622	50.3†	2 859 596	65.1	1.005	0.998 to 1.013	0.158			
Serum TG (mg/dL)	4 394 622	148.7†	2 859 596	65.1	1.000	1.000 to 1.001	0.411			
Haemoglobin (g/dL)	4 369 845	14.1†	2 848 403	65.2	1.029	0.968 to 1.093	0.360			
Haematocrit (%)	4 369 845	41.9†	2 848 403	65.2	1.008	0.986 to 1.032	0.471			
BUN (mg/dL)	4 394 622	15.5†	2 859 596	65.1	0.978	0.958 to 0.998	**0.033**			
Serum creatinine (mg/dL)	4 394 622	0.9†	2 859 596	65.1	1.095	0.725 to 1.655	0.665			
Urine protein										
Negative	3 913 238	89.1	2 519 106	64.4	Referent					
Positive	477 957	10.9	315 207	65.9	1.072	0.774 to 1.484	0.675			
Urine glucose										
Negative	4 199 401	95.6	2 708 365	64.5	Referent					
Positive	191 793	4.4	125 948	65.7	1.053	0.652 to 1.699	0.833			

Bold type indicates significant differences (p<0.05).
*Underestimated HI was defined as having AHL without SHD.
†Continuous variables are denoted by the mean.
‡Prevalence of underestimated HI in total population with AHL.
§Probability values and 95% CIs for ORs were corrected using Bonferroni's method for cases with multiple testing.
AHL, audiometrically measured hearing loss; BP, blood pressure; BUN, blood urea nitrogen; EQ-5D, Euro Qol-5D; HDL, high-density lipoprotein; HI, hearing impairment; SHD, self-reported hearing difficulty; TG, triglycerides.

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Table 3 Univariable and multivariable analyses of factors associated with overestimated hearing impairment

Variables	Total population with SHD		Overestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Personal factors										
Age (years)	3089060	56.3†	1451852	47.0	0.915	0.904 to 0.927	**<0.0001**	0.905	0.890 to 0.921	**<0.0001**
Sex										
Male	1574262	51.0	682372	43.3	0.741	0.576 to 0.954	**0.020**	0.660	0.424 to 1.029	0.067
Female	1514797	49.0	769480	50.8	Referent					
Smoke										
Never	1568370	50.8	787885	50.2	Referent					
Past smoker§	799930	25.9	314073	39.3	0.640	0.458 to 0.895	**0.006**	0.866	0.520 to 1.445	1.000
Current smoker§	720760	23.3	349894	48.5	0.935	0.640 to 1.365	1.000	0.597	0.351 to 1.017	0.061
Drinking alcohol in past year										
Non-drinker	998495	32.3	343984	34.5	Referent					
Drinker	2090565	67.7	1107867	53.0	2.145	1.650 to 2.788	**<0.0001**	1.150	0.784 to 1.687	0.475
Marital status										
Ever married	2792856	90.4	1191925	42.7	0.104	0.048 to 0.223	**<0.0001**	1.276	0.511 to 3.184	0.601
Never married	296204	9.6	259927	87.8	Referent					
Waist circumference (cm)	3089060	83.2†	1451852	47.0	0.977	0.964 to 0.991	**0.001**	0.988	0.964 to 1.014	0.363
Body mass index (kg/m^2)	3089060	24.0†	1451852	47.0	1.018	0.979 to 1.059	0.375			
Socioeconomic factors										
Income										
Lower	847736	27.4	232347	27.4	Referent					
Lower middle§	862386	27.9	399476	46.3	2.286	1.481 to 3.526	**<0.0001**	0.957	0.577 to 1.584	1.000
Upper middle§	681338	22.1	387641	56.9	3.496	2.187 to 5.588	**<0.0001**	1.244	0.739 to 2.093	0.951
Upper§	697599	22.6	432388	62.0	4.318	2.833 to 6.582	**<0.0001**	1.468	0.857 to 2.514	0.266
Education										
Less than high school	1610010	52.1	515579	32.0	Referent					
High school or more	1479050	47.9	936273	63.3	3.661	2.858 to 4.690	**<0.0001**	1.166	0.792 to 1.716	0.436
Employment status										
Employed	1738450	56.3	902568	51.9	1.575	1.224 to 2.027	**0.0004**	0.912	0.625 to 1.330	0.631
Unemployed	1350609	43.7	549284	40.7	Referent					
Quality of life										

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Table 3 Continued

Variables	Total population with SHD		Overestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
EQ-5D (%)										
Physical activity (mobility)										
Normal	2262057	73.2	1203774	53.2	Referent					
Limited	827002	26.8	248078	30.0	0.377	0.291 to 0.488	**<0.0001**			
Physical activity (self-care)										
Normal	2855547	92.4	1396588	48.9	Referent					
Limited	233513	7.6	55264	23.7	0.324	0.200 to 0.524	**<0.0001**			
Physical activity (usual activities)										
Normal	2566840	83.1	1296758	50.5	Referent					
Limited	522220	16.9	155094	29.7	0.414	0.306 to 0.560	**<0.0001**			
Physical activity (pain/discomfort)										
Normal	2084203	67.5	1008232	48.4	Referent					
Limited	1004857	32.5	443620	44.1	0.844	0.667 to 1.067	0.156			
Physical activity (anxiety/depression)										
Normal	2575106	83.4	1205708	46.8	Referent					
Limited	513954	16.6	246144	47.9	1.044	0.769 to 1.418	0.783			
EQ-5D index (%)										
Index<0.75	352500	11.4	108676	30.8	Referent					
0.75≤index < 1.00§	1112495	36.0	518799	46.6	1.960	1.219 to 3.151	**0.003**	0.987	0.563 to 1.730	1.000
Index=1.00§	1624065	52.6	824376	50.8	2.312	1.470 to 3.638	**<0.0001**	0.705	0.389 to 1.275	0.373
EQ-VAS (0 to 100)	3089060	69.1†	1451852	47.0	1.011	1.005 to 1.017	**0.001**			
Psychological factors										
Perceived health status										
Good§	759297	24.6	402665	53.0	1.164	0.798 to 1.697	0.736	1.342	0.893 to 2.017	0.212
Fair	1377238	44.6	678232	49.2	Referent					
Poor§	952524	30.8	370955	38.9	0.657	0.484 to 0.892	**0.004**	0.957	0.640 to 1.431	1.000
Body shape perception										
Too thin§	549060	17.8	185188	33.7	0.641	0.422 to 0.973	**0.035**	1.031	0.608 to 1.746	1.000
Just right	1290616	41.8	571135	44.3	Referent					
Too fat§	1249383	40.4	695530	55.7	1.582	1.158 to 2.162	**0.002**	1.312	0.874 to 1.968	0.269

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Table 3 Continued

Variables	Total population with SHD		Overestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Stress level										
Low	2134226	69.1	928488	43.5	Referent					
High	954834	30.9	523364	54.8	1.575	1.198 to 2.072	**0.001**	0.980	0.698 to 1.376	0.908
Depressive mood lasting for 2 weeks										
No	2455973	79.5	1154097	47.0	Referent					
Yes	633087	20.5	297755	47.0	1.002	0.730 to 1.375	0.992			
Health-related factors										
Vigorous physical activity practice										
Non-exercising	2676411	86.6	1206561	45.1	Referent					
Exercising	412648	13.4	245291	59.4	1.785	1.207 to 2.641	**0.004**	1.232	0.798 to 1.901	0.346
Moderate physical activity practice										
Non-exercising	2793226	90.4	1278209	45.8	Referent					
Exercising	295834	9.6	173643	58.7	1.684	1.103 to 2.571	**0.016**	1.191	0.738 to 1.923	0.474
Light physical activity practice										
Non-exercising	1925733	62.3	880948	45.7	Referent					
Exercising	1163327	37.7	570903	49.1	1.143	0.887 to 1.473	0.302			
Restricted use of medical services										
Yes	714039	23.1	341569	47.8	1.045	0.774 to 1.409	0.775			
No	2375021	76.9	1110283	46.7	Referent					
Health screening in past 2 years										
Yes	1904102	61.6	862214	45.3	0.836	0.651 to 1.073	0.158	1.134	0.823 to 1.562	0.441
No	1184958	38.4	589638	49.8	Referent					
Hospital visit in past 2 weeks										
Yes	1326445	42.9	560535	42.3	0.715	0.567 to 0.902	**0.005**	1.163	0.873 to 1.551	0.302
No	1762615	57.1	891317	50.6	Referent					
Hospitalisation in past year										
Yes	423019	13.7	211199	49.9	1.146	0.775 to 1.695	0.495			
No	2666041	86.3	1240652	46.5	Referent					
Obesity occurrence										
Underweight§	112572	3.6	50943	45.3	0.955	0.467 to 1.957	1.000			

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Table 3 Continued

Variables	Total population with SHD		Overestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
Normal	1 941 254	62.8	900 545	46.4	Referent					
Overweight§	1 035 234	33.5	500 364	48.3	1.081	0.819 to 1.428	1.000			
Medical history										
Hypertension										
Yes	937 031	30.3	318 681	34.0	0.463	0.361 to 0.595	**<0.0001**	1.501	1.061 to 2.123	**0.022**
No	2 152 029	69.7	1 133 171	52.7	Referent					
Myocardial infarction										
Yes	47 034	1.5	10 664	22.7	0.326	0.101 to 1.052	0.061	0.582	0.129 to 2.621	0.480
No	3 042 026	98.5	1 441 188	47.4	Referent					
Angina										
Yes	105 569	3.4	25 719	24.4	0.352	0.198 to 0.625	**0.0004**	0.848	0.422 to 1.705	0.643
No	2 983 490	96.6	1 426 132	47.8	Referent					
Asthma										
Yes	142 099	4.6	51 162	36.0	0.621	0.342 to 1.128	0.117	0.991	0.482 to 2.037	0.980
No	2 946 961	95.4	1 400 690	47.5	Referent					
Depression										
Yes	167 870	5.4	96 600	57.5	1.566	1.009 to 2.432	**0.046**	1.772	1.041 to 3.016	**0.035**
No	2 921 190	94.6	1 355 251	46.4	Referent					
Renal failure										
Yes	27 962	0.9	5801	20.7	0.292	0.049 to 1.733	0.175	0.442	0.065 to 2.987	0.402
No	3 061 098	99.1	1 446 051	47.2	Referent					
Diabetes mellitus										
Yes	375 984	12.2	113 868	30.3	0.447	0.303 to 0.658	**<0.0001**	1.140	0.725 to 1.792	0.569
No	2 713 075	87.8	1 337 984	49.3	Referent					
Auditory factors										
Tinnitus										
No	1 787 254	57.9	952 523	53.3	Referent					
Yes	1 301 805	42.1	499 329	38.4	0.545	0.427 to 0.697	**<0.0001**	0.523	0.391 to 0.699	**<0.0001**
Occupational noise exposure										
Yes	630 805	20.4	290 178	46.0	0.951	0.687 to 1.315	0.760			

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Table 3 Continued

Variables	Total population with SHD		Overestimated HI*		Univariable analysis			Multivariable analysis		
	Weighted frequency	Mean† or %	Weighted frequency	Prevalence (%)‡	OR	95% CI	P value	OR	95% CI	P value
No	2458254	79.6	1161674	47.3	Referent					
Laboratory measures										
Systolic BP (mm Hg)	3089060	122.8†	1451852	47.0	0.974	0.966 to 0.981	**<0.0001**	0.996	0.984 to 1.008	0.469
Diastolic BP (mm Hg)	3089060	76.5†	1451852	47.0	1.011	0.999 to 1.023	0.083	1.013	0.993 to 1.033	0.215
Total cholesterol (mg/dL)	2931858	191.5†	1396832	47.6	1.001	0.997 to 1.004	0.723			
HDL cholesterol (mg/dL)	2931858	50.7†	1396832	47.6	1.013	1.003 to 1.023	**0.011**			
Serum TG (mg/dL)	2931858	141.3†	1396832	47.6	0.999	0.998 to 1.000	0.149			
Haemoglobin (g/dL)	2913750	14.1†	1392308	47.8	1.038	0.953 to 1.132	0.392			
Haematocrit (%)	2913750	41.9†	1392308	47.8	1.012	0.980 to 1.045	0.463			
BUN (mg/dL)	2931858	14.9†	1535026	52.4	0.904	0.873 to 0.936	**<0.0001**			
Serum creatinine (mg/dL)	2931858	0.9†	1535026	52.4	0.330	0.169 to 0.646	**0.001**			
Urine protein										
Negative	2602155	89.2	1208023	46.4	Referent					
Positive	314670	10.8	151920	48.3	1.077	0.700 to 1.658	0.734			
Urine glucose										
Negative	2812935	96.4	1321898	47.0	Referent					
Positive	103890	3.6	38045	36.6	0.652	0.342 to 1.243	0.193			

Bold text indicates significant differences (p<0.05).
*Overestimated HI was defined as having SHD without AHL.
†Continuous variables are denoted by the mean.
‡Prevalence of overestimated HI in total population with SHD.
§Probability values and 95% CIs for OR were corrected using Bonferroni's method for cases with multiple testing.
AHL, audiometrically measured hearing loss; BP, blood pressure; BUN, blood urea nitrogen; EQ-5D, Euro Qol-5D; HDL, high-density lipoprotein; HI, hearing impairment; SHD, self-reported hearing difficulty; TG, triglycerides.

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audiometric HL among participants with SHD (table 3). In contrast to our result, Kamil *et al*[3] has reported that old age was related to underestimation of HI. The contradictory result between our study and Kamil *et al* may be due to the fact that younger people who underestimated HI were not included because they examined participants aged ≥50 years. Among 2609 participants with discrepancy between SHD and AHL in this study, underestimated HI was more prevalent in older participants than overestimated HI, and it might be attributed to a tendency of older population to consider their HL to be 'normal' for their age.[3]

For medical-related factors, participants who overestimated their HI significantly had more hypertension and depression than those who had concordant HI (table 3). Because hypertension is known to increase the risk of cochlea damage possibly through malfunction of the stria vascularis,[29] it might be related to early development of preclinical HL in auditory way. Also, hypertension and depression may influence the SHD in non-auditory way. Subjects with hypertension have worse overall health than subjects without hypertension, which in turn has been shown to be associated with an increased likelihood of reporting HD.[30] Studies have suggested that personality traits of neuroticism had a more adverse perception of their HD,[31 32] and it is widely known as an important factor that influences depression.[33] Accordingly, hypertension and depression may lead to an increased perception of HD. Moreover, as the present study is cross-sectional, it cannot be excluded that hypertension and depression is a result of SHD.

For auditory factors, tinnitus and occupational noise exposure were associated with concordant HI (tables 2 and 3). It is possible that these participants had an audiometric assessment for their tinnitus or occupational health screening programme and had known about their hearing status. Participants who had been exposed to occupational noise tended to have less underestimated HI regardless of tinnitus (table 2). As they are more likely to have severe HL than other participants, the severity of HL may affect SHD.[9]

Although a similar study from same dataset has been recently reported,[5] our study has several significant differences in approach. First, we excluded data from participants with abnormal TM who are more likely to have undergone a previous hearing evaluation. Second, we excluded normal hearing population with normal audiometry (<25 dB) and without SHD in the reference group, and confined the concordant HI group to those who showed both SHD and AHL as reference. However, Kim *et al*[5] had the concordance group including normal hearing population as reference. Because a large number of normal hearing people (93%) were included in their reference group, their analysis is likely to be biased by factors related to SHD or AHL, rather than focusing on the discrepancy between subjective hearing assessment and audiometry itself. Subgroup analysis for participants with ≥25 dB in Kim *et al*[5] showed that age, sex, education, occupation and stress were not associated with the discrepancy between subjective hearing assessment and audiometric thresholds. Lastly, this study analysed more variables including smoking status, alcohol consumption, waist circumference, body mass index, monthly income, marital status, quality of life, self-reported health status, body shape perception, noise exposure, physical activity, the use of medical service, current disease and serological data. Therefore, we expected that this study could provide more comprehensive information related to discrepancy between SHD and AHL.

In summary, the prevalence of discrepancy between SHD and AHL was 18.2% in South Korea. Age, medical histories of hypertension and depression, tinnitus and occupational noise exposure were associated with inconsistent results between self-reported and audiometrically measured hearing assessment in multivariable analysis. Understanding the factors related to self-reported hearing will assist clinicians in interpreting subjective reports of hearing and using these data as a surrogate measure of audiometry. These factors need to be considered when determining whether to conduct a hearing test, even if the patients do not report an HI.

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