



Association Between Hearing Level and Mental Health and Quality of Life in Adults Aged >40 Years

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Background and Objectives: In this study, we investigated the effects of hearing loss on mental health and quality of life (QoL) using survey data in adults aged >40 years. **Subjects and Methods:** We obtained data from 10,921 individuals who responded to the fifth Korean National Health and Nutrition Examination Survey. Primary outcomes were measured using questionnaires that recorded stress perception, depressive mood, and suicidal ideation to evaluate mental health and motor ability, self-management, activities of daily living, pain or discomfort, and anxiety or depression to evaluate QoL. **Results:** On multivariate analysis, suicidal ideation was more prevalent among older adults with hearing loss than in older adults without hearing loss. Motor ability was lower in individuals with hearing loss of >20 dB than in older adults with normal hearing. Categorization of the EuroQoL-5 Dimension (EQ-5D) health state into upper and lower groups showed that the EQ-5D values were lower in the moderate-to-severe hearing loss group than in the mild hearing loss group. **Conclusions:** Among adults aged >40 years, those with hearing loss experienced more suicidal ideation, had lower motor ability, and lower overall QoL compared with these variables in older adults with normal hearing. Additionally, QoL scores were low in individuals with poor hearing.

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Introduction

Elderly individuals with chronic diseases, such as chronic kidney disease, chronic lung disease, diabetes, hypertension, and osteoporosis, reported poorer mental health and quality of life (QoL) [1-3]. Hearing loss is a common symptom among older adults. In one study, one-third of the population over 65 years reported hearing loss [4]. Hearing loss progresses with age and we call it age-related hearing loss which is caused by cochlear degeneration [5-7].

Age-related hearing loss causes difficulties in communication and occupational discomfort [8]. Hearing loss also increases the risk of social isolation [9], which has many negative implications for elderly populations [10]. Hearing loss impacts mental health, physical function, and mortality [11-15] and has

psychosocial impacts, which include decreased emotional vitality, psychological well-being, and self-efficacy [16,17]. In addition to the psychological impacts of hearing loss on depression and poor well-being, suicide risk is emerging as an issue. Remarkably, in a French study, 10% of the elderly individuals with severe hearing loss reported suicidal ideation, and the trend increased over time [18]. However, this study was limited because the hearing loss was self-reported.

Overall, hearing loss has serious impacts on QoL and social welfare, especially in elderly populations [19,20]. Hearing loss gradually increases from the age of 40 years, and age-related hearing loss usually starts between the ages of 30 and 40 years [21]. A study from Yamasoba, et al. [22] demonstrated prevalent hearing loss increases from the age of 40. Still there are previous research regarding relationship between hearing loss and mental health, age adjustment was conducted in this study to evaluate the relationship. Therefore, our study focused on patients over 40 years to demonstrate the relationship between hearing level and mental health and QoL. This study

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aimed to identify the impact of hearing loss on mental health and QoL among older adults aged ≥ 40 years in South Korea using data from a national population survey.

Subjects and Methods

Patients

This was a retrospective study using data from the fifth wave (2010–2012) of the Korean National Health and Nutrition Examination Survey (KNHANES) (<https://knhanes.kdca.go.kr/>), conducted by the Korea Centers for Disease Control and Prevention of the Ministry of Health and Welfare. KNHANES is a nationwide cross-sectional survey conducted since 1998 in South Korea and includes 10,000 individuals per year. Audiometric examinations were included in the fifth dataset (wave 5) of this survey, from 2010 to 2012. Data collection and management can be found at https://knhanes.kdca.go.kr/knhanes/sub03/sub03_01.do. All participants were intentionally selected and comprised a representative sample of noninstitutionalized civilians in South Korea. This survey was a nationwide cross-sectional survey that included 10,000 individuals per year. The survey consisted of three components, namely, a health examination, a health interview, and a nutritional survey [23].

We analyzed data from 10,921 subjects out of the 13,661 adults >40 years who completed the KNHANES wave 5 QoL. We excluded 869 survey respondents who had experienced trauma or poisoning and 1,871 respondents who did not undergo audiometric testing. Participants who underwent audiometric assessments and completed a questionnaire about their psychological status and QoL were included (Fig. 1). The following data were also collected: sex, economic status, educational status, smoking status, alcohol consumption, body mass index (BMI), and history of hypertension, diabetes, anemia, stroke, arthritis, pulmonary tuberculosis, asthma, and visual disability.

This study was approved by the Asan Medical Center Institutional Review Board (2021-1366). A written informed consent was obtained from all participants before the study began.

Survey methods

Audiometric assessment

Audiometric testing was conducted in a small soundproof room to evaluate the air conduction threshold for each patient at four frequencies (0.5, 1, 2, and 4 kHz) using a manual testing protocol. Only the subject was in this quiet room at the time of the audiometric test. Pure tone audiometry (PTA)

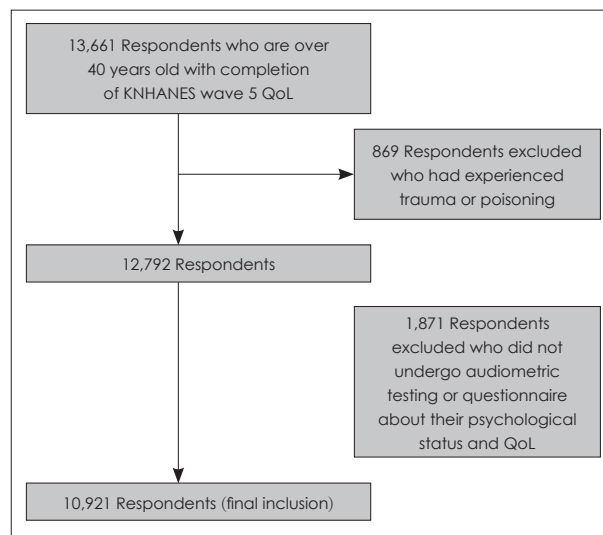


Fig. 1. Flow chart of inclusion. KNHANES, Korean National Health and Nutrition Examination Survey; QoL, quality of life.

was calculated using the average hearing thresholds for the four tones. Based on the World Health Organization's (WHO) definition of hearing impairment, normal hearing was defined as a PTA score of ≤ 20 dB HL in the better hearing ear. The degree of hearing loss was categorized as normal (0–20 dB HL), mild (>20 –40 dB HL), or moderate to severe (>40 dB HL).

Psychological status and QoL assessment

Participants' mental health was rated using a questionnaire about stress perception, depressive mood experience over the previous 2 weeks, and suicidal ideation. This questionnaire is the Korean version of the modified Patient Health Questionnaire (PHQ) developed in 1999 by Spitzer [24]. The subjects were asked "yes" or "no" questions and scored as 1 or 0, respectively. We measured participants' QoL using the Euro-QoL-5 Dimension (EQ-5D) index. EQ-5D is an instrument developed in Europe to measure the QoL. EQ-5D includes questions regarding whether participants had experienced any problems with motor ability, self-management, daily activities, pain or discomfort, or anxiety or depression [23]. In this study, QoL among the elderly was measured using EQ-5D. The EQ-5D was developed by EuroQoL and measures QoL for five dimensions at three or five levels [25]. The EQ-5D is widely used by many countries, including the United Kingdom, the United States, and Japan [26].

Analysis

Statistical analysis

Statistics for each EQ-5D category were calculated, and the total participants were divided into percentiles according to

their sum EQ-5D indices. Fig. 2 shows the distribution of EQ-5D scores. The distribution of respondents accounted for 80% and over. Therefore, we decided to use 20% as the cutoff to define low EQ-5D.

Statistical procedures were conducted to reflect the complex sampling design and sampling weights of KNHANES data. Data for continuous variables are presented as weighted means±standard errors (SE), and data for categorical variables are presented as the number of cases with a weighted percentage. Unadjusted and multivariable-adjusted logistic regression analyses were performed to correlate mental health and QoL with hearing level. We selected higher stress perception, the experience of depression mood over 2 weeks, suicidal ideation, motor ability, self-management, daily activity, pain or discomfort, anxiety or depression, and EQ-5D scores

as dependent variables for which odds ratios of age-adjusted hearing levels (PTA) were statistically significant. For suicide rate, motor ability, and low EQ-5D outcomes, the multivariable-adjusted models were adjusted for significant variables under the 10% significance level in the univariate analysis. Variables included in the multivariate analysis were sex, economic status, educational status, smoking status, alcohol consumption, BMI, history of hypertension, diabetics, anemia, stroke, arthritis, pulmonary tuberculosis, asthma, and visual disability. All statistical analyses were performed with the complex sample procedures of SAS version 9.4 (SAS Institute Inc., Cary, NC, USA). The *p*-values <0.05 were considered to be statistically significant. Overall *p*-values in tables indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered.

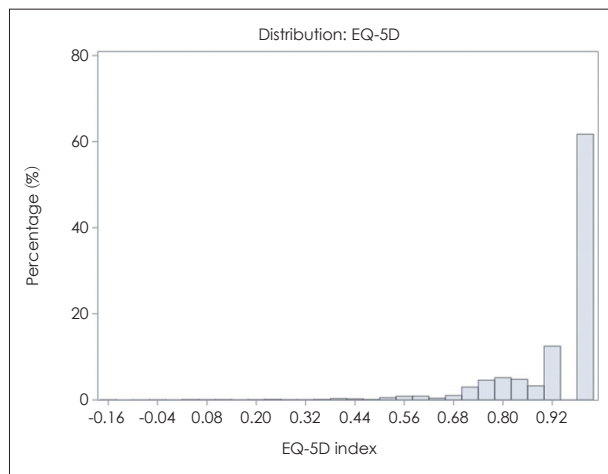


Fig. 2. Distribution of EuroQol-5 Dimension (EQ-5D) scores.

Results

Data from 10,921 respondents of the fifth wave of the KNHANES were analyzed and classified according to average hearing at four tone frequencies: 0.5, 1, 2, and 4 kHz. Participants’ hearing was classified as normal (0–20 dB HL, n=6,894), mild (>20–40 dB HL, n=3,128), or moderate to severe (>40 dB HL, n=899).

Table 1 presents the relationships between mental health—higher stress perception, depressive mood over 2 consecutive weeks, suicidal ideation—and hearing level. In univariate analysis, experience of depression mood and suicidal ideation were statistically significant according to hearing levels. Only suicidal ideation was significant in moderate to severe hearing loss when age was adjusted, while other parameters were not.

Table 1. Odds ratios for mental health according to hearing levels in individuals aged over 40 years based on univariate analyses and adjusted by age

Mental health	Hearing level (PTA)*	Univariate analysis		Adjusted by age	
		OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
Higher stress perception	Normal	1	-	1	-
	Mild	0.936 (0.827–1.059)	0.291	1.093 (0.950–1.257)	0.229
	Moderate to severe	0.855 (0.678–1.079)	0.187	1.097 (0.848–1.421)	0.351
	Overall <i>p</i> -value	-	0.291	-	0.441
Experience of depression mood (>2 weeks)	Normal	1	-	1	-
	Mild	1.185 (1.022–1.373)	0.024	1.046 (0.890–1.230)	0.586
	Moderate to severe	1.290 (1.009–1.650)	0.043	1.060 (0.808–1.389)	0.674
	Overall <i>p</i> -value	-	0.020	-	0.833
Suicidal ideation	Normal	1	-	1	-
	Mild	1.369 (1.181–1.587)	<0.0001	1.042 (0.892–1.217)	0.604
	Moderate to severe	1.983 (1.582–2.484)	<0.0001	1.296 (1.023–1.641)	0.032
	Overall <i>p</i> -value	-	<0.0001	-	0.099

*normal, PTA ≤20 dB; mild, >20–40 dB; and moderate to severe, >40 dB. Overall *p*-values indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered. PTA, pure tone audiometry; OR, odds ratio; CI, confidence interval

Multivariate analysis was performed only univariate variable is statistically significant. Multivariate analyses using meaningful variables (age, sex, economic status, educational status, alcohol consumption, BMI, hypertension, diabetics, anemia, stroke, arthritis, asthma, and visual disturbance) for suicidal ideation revealed that subjects over age 40 with moderate to severe hearing loss experienced significantly more suicidal ideation than subjects with normal hearing (odds ratio [OR]=1.337, $p=0.025$) (Table 2).

Table 3 presents the relationship between QoL and hearing level in adults over 40 years old ($n=10,921$). All parameters of QoL were related to hearing level in univariate analysis. How-

ever, most of parameters presented no relationship when age was adjusted except motor ability and daily activity in mild hearing. Multivariate analysis showed significantly poorer motor ability in subjects with hearing loss, and motor ability scores were lower in the poor hearing group ($p=0.006$, $p=0.011$) (Table 4).

Table 5 present the relationships between QoL and hearing level. Using the EQ-5D score, 20% was set as the cutoff to define low EQ-5D. When EQ-5D was divided into upper and lower groups, EQ-5D scores were significantly associated with hearing levels over age 40 ($n=10,921$). According to the multivariate analysis, QoL was lower in the poor hearing group

Table 2. Odds ratios for suicidal ideation according to hearing level in individuals aged over 40 years based on multivariate analyses

Mental health	Hearing level (PTA)*	Multivariate analysis	
		OR (95% CI)	p-value
Suicidal ideation	Normal	1	-
	Mild	1.086 (0.915–1.289)	0.343
	Moderate to severe	1.337 (1.038–1.723)	0.025
	Overall p-value	-	0.078

*normal, PTA ≤ 20 dB; mild, $>20-40$ dB; and moderate to severe, >40 dB. Overall p-values indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered. PTA, pure tone audiometry; OR, odds ratio; CI, confidence interval

Table 4. Odds ratios for motor ability according to hearing level in individuals aged over 40 years based on multivariate analyses

Motor health	Hearing level (PTA)*	Multivariate analysis	
		OR (95% CI)	p-value
Motor ability	Normal	1	-
	Mild	1.274 (1.073–1.512)	0.006
	Moderate to severe	1.426 (1.087–1.872)	0.011
	Overall p-value	-	0.006

*normal, PTA ≤ 20 dB; mild, $>20-40$ dB; and moderate to severe, >40 dB. Overall p-values indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered. PTA, pure tone audiometry; OR, odds ratio; CI, confidence interval

Table 3. Odds ratios for QoL according to hearing level aged over 40 years based on univariate analyses and adjusted by age

QoL	Hearing level (PTA)*	Univariate analysis		Adjusted by age	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Motor ability	Normal	1	-	1	-
	Mild	3.182 (2.815–3.597)	<0.0001	1.214 (1.043–1.413)	0.013
	Moderate to severe	5.114 (4.180–6.256)	<0.0001	1.160 (0.924–1.455)	0.200
	Overall p-value	-	<0.0001	-	0.043
Self-management	Normal	1	-	1	-
	Mild	3.554 (2.777–4.549)	<0.0001	1.276 (0.960–1.696)	0.093
	Moderate to severe	5.418 (4.084–7.188)	<0.0001	1.182 (0.840–1.663)	0.338
	Overall p-value	-	<0.0001	-	0.244
Daily activity	Normal	1	-	1	-
	Mild	3.044 (2.600–3.565)	<0.0001	1.199 (1.004–1.432)	0.045
	Moderate to severe	4.677 (3.696–5.920)	<0.0001	1.144 (0.881–1.485)	0.312
	Overall p-value	-	<0.0001	-	0.131
Pain or discomfort	Normal	1	-	1	-
	Mild	1.667 (1.483–1.874)	<0.0001	0.981 (0.858–1.122)	0.779
	Moderate to severe	1.883 (1.528–2.321)	<0.0001	0.820 (0.660–1.019)	0.073
	Overall p-value	-	<0.0001	-	0.194
Anxiety or depression	Normal	1	-	1	-
	Mild	1.373 (1.173–1.608)	<0.0001	0.977 (0.813–1.174)	0.803
	Moderate to severe	1.553 (1.202–2.006)	0.0001	0.914 (0.676–1.237)	0.560
	Overall p-value	-	<0.0001	-	0.844

*normal, PTA ≤ 20 dB; mild, $>20-40$ dB; and moderate to severe, >40 dB. Overall p-values indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered. QoL, quality of life; PTA, pure tone audiometry; OR, odds ratio; CI, confidence interval

Table 5. Odds ratio of divided EQ-5D value (upper and lower 20%) according to hearing level aged over 40 years in univariate and multivariate analysis

Age group	Hearing level (PTA)	Univariate analysis		Multivariate analysis	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Age ≥40, total	Normal	1	-	1	-
	Mild	3.101 (2.755–3.491)	<0.0001	1.294 (1.091–1.534)	0.003
	Moderate to severe	4.706 (3.831–5.781)	<0.0001	1.349 (1.018–1.787)	0.037
	Overall p-value	-	<0.0001	-	0.008

*normal, PTA ≤20 dB; mild, >20–40 dB; and moderate to severe, >40 dB. Overall p-values indicate the statistical significance when normal, mild, and moderate severe hearing levels are all considered. EQ-5D, EuroQoL-5 Dimension; PTA, pure tone audiometry; OR, odds ratio; CI, confidence interval

over age 40 (mild hearing loss: OR=1.294, $p=0.003$; moderate to severe hearing loss: OR=1.349, $p=0.037$).

Discussion

Age-related hearing loss is associated with deteriorating mental health [11]. Cosh, et al. [27] found positive associations between hearing loss and mental health problems such as poor cognitive function, suicidal ideation, and anxiety. Park, et al. [28] also reported significant health disparities. Particularly, hearing loss was positively associated with suicidal ideation, highlighting the importance of hearing loss as a health-care issue. Hearing impairment is also related to reduced motor activity [12].

Our findings also support the connection between hearing loss and mental health. In our study, suicidal ideation increased as hearing loss worsened in adults over age 40. We found that suicidal ideation was significantly related to hearing loss of more than 40 dB in adults over 40 years of age, in contrast to the normal hearing group. Study from Hallam, et al. [29], demonstrated the psychosocial impact was related to the degree of hearing loss, as what our study demonstrated. Aging discourages social activity because the discomfort from age-related comorbidities accelerates social isolation. In particular, moderate to severe hearing loss can greatly contribute to social isolation due to the severe limitations on communication, and this isolation can increase suicidal ideation [27].

The WHO defines QoL as “an individual’s perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards, and concerns” [30]. Hearing loss is associated with multiple QoL indicators, including activities of daily living and self-management. In a systematic review, Dixon, et al. [31] demonstrated that multiple elements were associated with health-related QoL, including body function (memory, emotion, hearing, motivation), activities and participants (family relationship, education, community life), and environmental factors (family support, health services and systems). Hearing

loss typically impairs all of these QoL elements. Indeed, earlier research showed that poor QoL subjects with hearing loss was associated with limited social relationships and poor emotional interactions. In turn, these poor social interactions can cause social isolation and family issues [32].

Hearing loss can isolate adults and decrease their social activity, which can decrease their motor activity. We believe that moderate to severe hearing loss greatly limits social activities in these individuals, whereas adults with mild hearing loss are socially active and felt their decreased motor and social activity more acutely. Adults with moderate to severe hearing loss was associated more with severe motor ability deterioration than mild hearing loss. Moderate to severe hearing loss might require auditory rehabilitation, such as a hearing aid, which can affect QoL.

Many studies have focused on the relationship between hearing loss and mental health and QoL [5,8,12,17,18,27,28,31]. Previous studies have shown that hearing loss affects mental health and QoL in individuals over 40 years old and this study also demonstrated similar results. There are several factors that could reduce mental health and QoL such as age, other comorbidities and etc. This study suggested hearing loss itself can be a risk factor of reduced mental health and QoL. Therefore, we adjusted the age and performed multivariate analysis to identify the relationship between hearing loss itself to mental health and hearing loss using national-wide data.

This study has several limitations. This was a retrospective study using KNHANES data. Although multivariate analyses were used to exclude confounders that could have affected mental health and QoL, it cannot conclude that hearing loss is the only factor contributing to decreased mental health and QoL. Because this was a cross-sectional observational study, long-term findings for mental health and QoL related to hearing loss could not be anticipated. Our findings highlight the importance and necessity of audiometric rehabilitation for subjects with hearing loss, considering the implications for mental health and QoL. However, any outcomes related to hearing aids or other rehabilitations were not demonstrated.

Despite these limitations, this study supports the connection between hearing loss in the population and severe effects on mental health and QoL.

In conclusion, we found that suicidal ideation in Korean adults over 40 years of age was higher among people with moderate to severe hearing loss. Motor activity and QoL scores were also lower in the poor hearing level group. According to these results, poor hearing levels in adults over age 40 are associated with low mental health and overall QoL.

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Conflicts of Interest

The authors have no financial conflicts of interest.

Author Contributions

Conceptualization: Jong Woo Chung. Data curation: Junyong Go. Formal analysis: Yeonjoo Choi. Funding acquisition: Jong Woo Chung. Investigation: Jong Woo Chung. Methodology: Yeonjoo Choi. Project administration: Jong Woo Chung. Resources: Yeonjoo Choi. Software: Junyong Go. Supervision: Jong Woo Chung. Validation: Jong Woo Chung. Visualization: Junyong Go. Writing—original draft: Yeonjoo Choi. Writing—review & editing: Yeonjoo Choi, Junyong Go. Approval of final manuscript: all authors.

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