전정기능이 건강 관련 삶의 질에 미치는 영향: 국민건강영양조사를 중심으로

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Impact of Vestibular Function on Health-Related Quality of Life: A Cross-Sectional Study Based on Korea National Health and Nutrition Examination Survey

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Objectives: This study was performed to investigate whether vestibular dysfunction affects health-related quality of life in Korean adults.

Methods: This retrospective cross-sectional study was performed with data from the 2010 to 2011 Korea National Health and Nutrition Survey for adults aged 40 years or more. The modified Romberg test and health-related quality of life evaluation using the EuroQoL 5-dimensional (EQ-5D) questionnaires were performed. Data were analyzed using a complex-sample chi-square test of independence and multivariate linear regression analysis. The main outcome measures were vestibular dysfunction and the calculated health-related quality of life questionnaire score.

Results: The overall prevalence of vestibular dysfunction was 3.4% (95% confidence interval, 2.5%–4.3%). In adults aged more than 40 years, multivariate linear regression analyses showed a significant reverse correlation between vestibular function and health-related quality of life since the EQ-5D index showed a lower score than normal (B coefficient=−0.09, $R^2=0.299$, $p=0.003$) for a decrease in balance function, and the scores for mobility, self-care, general activities, and pain/discomfort were worse, except for anxiety/depression. On the other hand, subjective dizziness was significantly associated with the EQ-5D index and all its subcategories.

Conclusions: Since adults with vestibular dysfunction have poor health-related quality of life, active monitoring and rehabilitation are necessary.

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Keywords: Korea National Health and Nutrition Examination Surveys; Vestibular diseases; Vertigo; Quality of life; Risk factors

INTRODUCTION

Dizziness and vertigo are responsible for a gradual increase

in medical expenses and have become an emerging health concern [1,2]. The vestibular origin accounts for a significant proportion of the multifactorial causes of dizziness [3]. In

particular, patients with reduced balance function often experience difficulties in everyday life, which increases their risk of falling [4]. However, large-scale studies, especially domestic studies, on the relationship between equilibrium function and quality of life are limited.

The present study was based on the hypothesis that vestibular dysfunction may be associated with quality of life (with all factors of the overall quality of life). We focused on examining the relationship between vestibular function and quality of life using a large database from the Korea National Health and Nutrition Survey (KNHNS). We investigated the correlation between the actual equilibrium function and quality of life. Further, the quality of life in patients complaining of subjective dizziness was compared and analyzed with the main results. We expect that the results will provide basic and useful information that will facilitate the evaluation and management of related diseases and education of patients.

MATERIALS AND METHODS

1. Sociodemographic and Clinical Factors Related to Quality of Life

The KNHNS was conducted by the Korea Centers for Disease Control and Prevention to obtain national statistics to assess the health and nutritional status of Koreans. This study is based on data from a one-year (2010–2011) survey sampled using a stratified cluster extraction method for the entire population of Korea. The first study followed the Helsinki Declaration and was approved by the appropriate Ethics Review Board. All participants provided prior consent. This study was approved by the Institutional Review Board of Jeju National University Hospital as the second study (No. 2020-06-012).

Data on demographic factors or health-related behaviors of the study subjects were collected through personal interviews conducted by experienced interviewers. The demographic variables included age, sex, education level, monthly income, marital and employment status, and smoking and alcohol consumption. According to the standards of the KNHNS, high-risk drinking was defined as consumption of more than seven cups (60 g or more) of alcohol more than twice a week for men

and consumption of more than five cups (40 g or more) of alcohol at least twice a week for women.

Of the 4,126 selected participants, 48.2% were male and 51.8% were female. The mean age of the participants was 55.49 ± 0.32 years (mean $\pm$ standard error [SE]). Household income was categorized into the lowest (<25th percentile), low-middle (25th–49th percentile), medium-high (50th–74th percentile), and highest ($\geq$ 75th percentile) groups. The education level was categorized into elementary school or less, middle school graduate, high school graduate, and college graduate or higher. Medical histories were evaluated according to the International Statistical Classification of Diseases and Related Health Problems, 10th revision codes if the participants had been diagnosed with chronic diseases (hypertension, diabetes mellitus, cardiovascular disease [myocardial infarction or angina], stroke, arthritis, chronic kidney disease, and cancer).

KNHNS performed vestibular function evaluation in participants aged over 40 years. In addition to the equilibrium function test, an analysis of otolaryngological hearing loss and otitis media, which may be associated with equilibrium function, was also performed. Hearing impairment was considered to be present if the mean value of the air-conduction thresholds for the 500-, 1,000-, 2,000-, and 4,000-Hz pure-tone sounds was greater than 40 dB in at least one ear. Chronic otitis media was diagnosed by trained otolaryngologists based on responses to a questionnaire and otoendoscopic findings. Lastly, the participants' response(s) to a question/questionnaire on factors that can affect the quality of life (visual disabilities, stress level, and depressive mood) was collected.

2. Evaluation of Vestibular Function

The participants performed a modified Romberg test involving standing and maintaining balance on firm and compliant surfaces. Participants were instructed to cross their arms, straighten their knees, and stand with their arms crossed and feet 10 cm apart on a hard surface for at least 15 seconds. Eyes were opened in the first condition and closed in the second condition. The participants were then instructed to open their eyes (third condition) or close them (fourth condition) while standing on an 18-cm-thick foam pad for more than 20 seconds,

which satisfied the conditions for removing somatosensory information. The fourth condition provides information regarding vestibular function. The participants who passed the test in the first, second, and third conditions but failed in the fourth condition were considered to exhibit vestibular dysfunction. Participants who failed in the fourth condition and at least one of the first three conditions were not considered to have vestibular dysfunction in the analysis. A total of 3,985 (96.6%) of the 4,126 participants passed the test in the first three conditions and also succeeded in the fourth condition.

3. Evaluation of Health-Related Quality of Life

Health-related quality of life (HRQoL) refers to areas of life that are directly affected by changes in health. To assess this, we used the Korean version of EuroQoL 5-dimensional (EQ-5D), the tool evaluating HRQoL that was developed by the EuroQoL group founded in 1987 [5,6]. The EQ-5D consists of five multiple-choice questions assessing current health status, including mobility, self-care, general activities, pain/discomfort, and anxiety/depression. The responses to each question include “no problem (level 1),” “some/moderate problem (level 2),” and “extreme problem (level 3)” (Supplementary material). The respondents are asked to choose the answer that best describes their health. The EQ-5D index is calculated by applying weights for each of the 243 health conditions covered in the 5 EQ-5D questions, thereby providing a comprehensive assessment of HRQoL. If all items are displayed to the maximal extent, the calculated value is 1, and if the extent of the item is not fully exhibited, it shows a negative value with an eventual range of -0.171 to 1 .

4. Statistical Analysis

The factors related to vestibular dysfunction were analyzed using PASW Statistics ver. 18 (IBM Corp., Armonk, NY, USA). The values in this study were categorical variables and are expressed as percentages. The chi-square test was used to compare the prevalence of vestibular dysfunction. Multivariate statistical analysis was performed using weighting according to the guidelines for the use of preliminary data by the Korea Centers

for Disease Control and Prevention. A complex-sample plan file was designed to apply k strata, primary sample units, and proper usage of sampling weight values. The relationship between vestibular dysfunction and the HRQoL index was investigated after correcting for confounding factors using multiple linear regression analysis. A p -value of <0.05 was considered statistically significant.

RESULTS

1. The Relationship between Vestibular Dysfunction and the Sociodemographic and Clinical Characteristics of the Participants: Univariate Analysis

A total of 141 participants (3.4%) out of the 4,126 had vestibular dysfunction. The analysis of the evaluation items according to the decline in vestibular function is presented in Table 1. In the participants showing a vestibular function decline, the EQ-5D index was 0.77 ± 0.03 (mean $\pm$ SE), which was lower than the value in the normal participants (0.94 ± 0.003 , $p < 0.001$). Moreover, in comparison with those in the normal group, participants in the vestibular dysfunction group were older and included a higher proportion of women. The vestibular dysfunction group also contained higher proportions of underweight, less-educated, unemployed participants and participants with a low income level and those without a spouse.

In comparison with participants showing normal vestibular function, the vestibular dysfunction group showed a higher prevalence of stroke, arthritis, hypertension, and diabetes mellitus; higher rates of hearing loss or chronic otitis media; and a higher rate of decreased vestibular function when there was a problem with vision.

2. Vestibular Dysfunction and EQ-5D Index and Subcategories of EQ-5D: Multivariate Analysis

Based on the results showing an association between vestibular function and quality of life in the above results, we performed corrections for proven covariables and performed additional multiple linear regression analyses (Table 2). In model 1, which was adjusted only for sex and age, a lower

Table 1. Prevalence of vestibular dysfunction according to the general characteristics of the participants

Variable	Normal vestibular function	Vestibular dysfunction	<i>p</i> -value
EQ-5D index	0.94 (0.003)	0.77 (0.030)	<0.001*
Age (yr)	54.95 (0.304)	69.24 (1.463)	<0.001*
Sex, female	51.4 (0.7)	64.4 (4.8)	0.013*
Body mass index			0.009*
Underweight	2.3 (0.3)	9.1 (2.8)	
Normal	62.2 (0.9)	64.9 (5.2)	
Overweight	35.5 (0.9)	26.0 (5.5)	
Education level, lowest quartile	31 (1.4)	73.3 (6.0)	<0.001*
Household income, lowest quartile	21.4 (1.2)	42.1 (4.8)	0.001*
Employed, no	32.9 (1.2)	63.2 (5.1)	<0.001*
Marital status, no	14.8 (0.8)	43.7 (5.4)	<0.001*
Current smoker, yes	23.8 (0.9)	13.9 (4.8)	0.109
Alcohol binge drinker, yes	45.2 (1.3)	37.7 (7.4)	0.327
Stress level, moderate or extreme	24.9 (0.8)	33.6 (5.7)	0.114
Depressive mood, ≥2 wk	14.2 (0.7)	20.7 (3.9)	0.065
Chronic kidney disease	0.4 (0.4)	0.7 (0.7)	0.539
Stroke	1.6 (0.2)	5.0 (1.8)	0.003*
Myocardial infarction or angina	3.4 (0.3)	3.2 (1.5)	0.881
Arthritis	18.8 (0.7)	36.5 (5.4)	<0.001*
Hypertension	27.4 (0.9)	53.6 (4.9)	<0.001*
Diabetes mellitus	9.9 (0.5)	25.3 (5.3)	<0.001*
Hearing impairment	7.0 (0.6)	29.1 (5.2)	<0.001*
Cancer	4.1 (0.4)	4.8 (2.0)	0.715
Chronic otitis media	4.9 (0.5)	10.5 (3.7)	0.043*
Visual impairment	0.7 (0.2)	4.3 (2.5)	0.020*
Self-perceived dizziness, severe	2.2 (0.3)	16.4 (4.0)	<0.001*

Values are presented as percentage (standard error).

Weighted prevalence was computed to provide estimates for the total South Korean population.

EQ-5D, the EuroQoL 5-dimensional questionnaires.

*Statistically significant ($p < 0.05$) according to the univariate linear model.

Table 2. Regression analysis of the association between vestibular dysfunction and health-related quality of life

Variable	Value (SE)	Model 1			Model 2		
		β coefficient (95% CI)	<i>p</i> -value	R ²	Adjusted β coefficient (95% CI)	<i>p</i> -value	R ²
EQ-5D index	0.77 (0.03)	-0.11 (-0.16 to -0.05)	<0.001*	0.191	-0.09 (-0.15 to -0.03)	0.003*	0.299
Mobility	1.62 (0.07)	0.25 (0.13 to 0.36)	<0.001*	0.194	0.21 (0.8 to 0.34)	0.002*	0.280
Self-care	1.30 (0.06)	0.21 (0.1 to 0.32)	<0.001*	0.077	0.21 (0.09 to 0.33)	0.001*	0.118
Usual activity	1.55 (0.09)	0.29 (0.12 to 0.46)	0.001*	0.139	0.25 (0.07 to 0.42)	0.005*	0.215
Pain/discomfort	1.66 (0.08)	0.23 (0.09 to 0.38)	0.002*	0.09	0.21 (0.05 to 0.36)	0.011*	0.160
Anxiety/depression	1.24 (0.05)	0.07 (-0.03 to 0.18)	0.166	0.029	0.07 (-0.05 to 0.19)	0.239	0.080

β coefficients are estimated values that reflect the complex-sample weight.

Model 1: adjusted for sex and age. Model 2: adjusted for age, sex, education, household income, employment, marital status, stroke, arthritis, hypertension, diabetes mellitus, hearing impairment, chronic otitis media, and visual impairment.

SE, standard error; CI, confidence interval EQ-5D, the EuroQoL 5-dimensional questionnaires.

*Statistically significant ($p < 0.05$).

EQ-5D index score was found in the case of vestibular hypo-function. In further analyses, subcategories of mobility, self-care, usual activity, and pain/discomfort showed higher discom-

fort scores. However, only depression/anxiety score did not show a significant correlation with vestibular function. The same pattern of results was obtained in the analysis with model

Table 3. OR (95% CI) for depressed mood according to vestibular dysfunction/self-perceived dizziness

Variable	Percentage (SE)	Model 1		Model 2	
		OR (95% CI)	<i>p</i> -value	OR (95% CI)	<i>p</i> -value
Vestibular dysfunction					
Depressive mood, ≥2 wk	20.7 (3.9)	1.581 (0.972–2.570)	0.065	1.067 (0.586–1.942)	0.831
Stress level, moderate or extreme	33.6 (5.7)	1.528 (0.903–2.586)	0.114	1.683 (0.866–3.270)	0.124
Self-perceived dizziness, severe					
Depressive mood, ≥2 wk	31.9 (5.9)	2.884 (1.675–4.966)	<0.001*	2.395 (1.307–4.390)	0.005*
Stress level, moderate or extreme	43.3 (5.0)	2.860 (1.858–4.402)	<0.001*	3.100 (1.978–4.858)	<0.001*

Model 1: adjusted for sex and age. Model 2: adjusted for age, sex, education, household income, employment, marital status, stroke, arthritis, hypertension, diabetes mellitus, hearing impairment, chronic otitis media, and visual impairment.

SE, standard error; OR, odds ratio; CI, confidence interval.

*Statistically significant ($p < 0.05$).

Table 4. Regression analysis of the association between self-perceived dizziness and health-related quality of life

	Value (SE)	Model 1			Model 2		
		β coefficient (95% CI)	<i>p</i> -value	R^2	Adjusted β coefficient (95% CI)	<i>p</i> -value	R^2
EQ-5D index	0.80 (0.029)	−0.090 (−0.144 to −0.037)	$<0.001^*$	0.191	−0.067 (−0.117 to −0.018)	0.008*	0.283
Mobility	1.55 (0.071)	0.209 (0.078 to 0.340)	$<0.001^*$	0.211	0.187 (0.053 to 0.322)	0.007*	0.297
Self-care	1.28 (0.054)	0.176 (0.076 to 0.275)	0.001*	0.086	0.134 (0.045 to 0.223)	0.003*	0.118
Usual activity	1.48 (0.085)	0.238 (0.084 to 0.392)	$<0.001^*$	0.151	0.190 (0.045 to 0.335)	0.011*	0.216
Pain/discomfort	1.62 (0.094)	0.210 (0.030 to 0.390)	0.023*	0.095	0.231 (0.030 to 0.431)	0.024*	0.162
Antiety/depression	1.36 (0.071)	0.196 (0.056 to 0.335)	0.006*	0.040	0.159 (0.038 to 0.280)	0.010*	0.081

β coefficients are estimated values that reflect the complex-sample weight.

Model 1: adjusted for sex and age. Model 2: adjusted for age, sex, education, household income, employment, marital status, stroke, arthritis, hypertension, diabetes mellitus, hearing impairment, chronic otitis media, and visual impairment.

SE, standard error; CI, confidence interval EQ-5D, the EuroQoL 5-dimensional questionnaires.

*Statistically significant ($p < 0.05$).

2, which was adjusted for all statistically significant covariates.

DISCUSSION

3. Differences in Psychological Measures and EQ-5D between Perceived Dizziness and Vestibular Dysfunction Groups

When dividing the patients into those complaining of current severe dizziness and the others, the odds ratio (OR) for feeling depressed for 2 consecutive weeks was 2.884 (95% confidence interval [CI], 1.675–4.966; $p < 0.001$) and the OR for the presence of severe stress was also 2.860 (95% CI, 1.858–4.402; $p < 0.001$), implying a clear connection between subjective dizziness and the psychological status (depression/anxiety) ($p = 0.006$) (Table 3). In addition, this result was clearly related to the deterioration of all components of quality of life in the linear regression analysis corrected for covariables (Table 4).

The results of this study showed that the deterioration in objective equilibrium function is correlated with a decrease in HRQoL. Although previous studies have discussed the relationship between dizziness and functional, emotional, and physical limitations, most of them were restricted to patients who visited the hospital for dizziness [7–9]. Thus, those studies might have suffered from a selection bias. In those studies, patients who perceived a larger disability due to dizziness experienced greater functional impairment than those who perceived less dizziness. Jacobson et al. [10] also suggested a close correlation between postural performance results and the scores on the Dizziness Handicap Inventory (DHI; a self-reported measurement tool for patients with dizziness with three content domain subgroups representing the functional, emotional, and physical aspects of dizziness and unsteadiness).

However, other studies suggested that DHI does not correlate with vestibular function itself, and that it neither reflects the presence nor the severity of peripheral vestibular deficits [11-13]. These inconsistent findings can be attributed to the fact that each study used a study population with varying degrees of vestibular function, necessitating a comparative study using normal subjects for a more comprehensive assessment.

Recent Korean studies suggested a link between quality of life and vestibular function but they did not adjust for the effects of possible covariates in their analyses [14,15]. The present study expanded the target audience to the general population representing Korean adults, and clearly established the correlation between the quality of life and vestibular function with controlling variables.

An interesting finding of this study is that the aspect of “depression and anxiety” does not show a significant relationship with vestibular function itself. Moreover, not all patients who experienced dizziness showed a decrease in vestibular function (also shown in Table 1; subjects with reduced balance function have more symptoms, but not all of them complained of severe dizziness). In addition, patients may show both symptoms and dysfunction or present with only one of the two. Among the study participants, 2.7% (2.0%–3.7%) complained of current severe dizziness, while 10.4% (8.7%–12.4%) answered that they had experienced dizziness within a year but it had now improved (data not shown). This shows the discrepancy between the presence of symptoms and balance dysfunction. In further analyses, perceived severe dizziness cases showed definite association with stress or depressive perception compared to that of objective vestibular dysfunction (Table 3), resulting in decrease in all domains of HRQoL (Table 4).

On the basis of these findings, we can summarize that both objective equilibrium dysfunction and subjective dizziness are clearly associated with a poor quality of life, but only severe symptomatic dizziness is associated with a statistically significant psychological deterioration. Neurological linkage has been reported to be evidence of the co-occurrence of dizziness and anxiety [9,16]. Monoaminergic input to the vestibular system mediates the effects of anxiety on vestibular function and the nuclear network around the arm can mediate the emotional response to vestibular dysfunction. In addition,

neurological linkages in the brain circuitry are involved in both vestibular processing and anxiety. The vestibular nuclei are connected to the parabrachial nucleus, which in turn is functionally connected to regions that control manifestations of anxiety. However, despite this evidence, our clinical data show that the vestibular decline is not always accompanied by anxiety.

Discrepancies among symptoms, function, and depression also exist in actual clinical situations. For example, persistent postural-perceptual dizziness, which is being increasingly diagnosed, is a newly defined syndrome unifying chronic subjective dizziness, phobic postural vertigo, and related disorders, in which the patients show negative results in the diagnostic test (i.e., they do not show hypofunction) but they experience persistent symptoms. The prevalence of functional dizziness as a primary cause of vestibular symptoms in neurotology centers is 10%. Even in patients with negative diagnostic test results, the rates of psychiatric comorbidity (with complaints of considerable stress) are considerably high (up to 50%) [17,18]. These findings showing the close correlation between subjective dizziness and anxiety add explanatory power to the results of this study.

Despite the statistically significant differences in psychological aspects between patients with balance dysfunction and those presenting with symptoms, active intervention is absolutely required in both groups of patients due to the deterioration of their quality of life. Moreover, the finding showing the considerable prevalence of subjective dizziness and the increased stress score in these patients should not be overlooked.

Another aspect was that the decline in vestibular function was more common in old age (Table 1), with people complaining of severe dizziness being older than those who did not (63.6 ± 1.60 years vs. 55.43 ± 0.31 years, mean $\pm$ SE; data not shown). In the current aging society, the quality of life of the elderly is important, indicating the need for active management.

Although only 16.4% of people with poor vestibular function complained of severe dizziness, the fact that the quality of life deteriorates without the appearance of any serious symptoms should not be overlooked.

Due to the limitations of population-based cross-sectional studies, the histories of symptomatic dizziness and the duration,

severity, and cause of the deterioration (different vestibular disorders [central, peripheral, and functional] of the equilibrium function) are not known. Further studies are needed to determine how the quality of life score changes when these factors change. These results should provide more information about the reasons for the gap between the two sets of results. Although our result confirmed the significant and independent effect of vestibular function on HRQoL adjusted a wide array of proven correlated covariates, there was a limitation of the survey questionnaire and additional patient characteristics such as comorbid conditions might be associated with the HRQoL.

In summary, the implication of this study is that the state of vestibular dysfunction has a significant adverse effect on the quality of life. Therefore, active identification of the dysfunction and rehabilitation and intervention for patients showing this dysfunction is recommended. In particular, for patients who complain of severe subjective dizziness, medical staff should also strive to provide psychological support.

중심 단어: 국민건강영양조사, 전정기능 저하, 현훈, 삶의 질, 위험요인

CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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SUPPLEMENTARY MATERIALS

Supplementary material can be found via <https://doi.org/10.21790/rvs.2021.20.1.17>.

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