Association Between Household Food Insecurity and Dizziness or Balance Disturbance in Korean Older Adults

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Abstract

Background: Food insecurity is defined as economic and social conditions that limit access to enough food to live a healthy life. The elderly are among the first to experience food insecurity, and we aim to investigate the association between food insecurity and dizziness, one of the most common complaints in geriatric health.

Methods: This study was a cross-sectional study used data from the eighth of the Korea National Health and Nutrition Examination Survey. Of the 22,559 participants, 3002 participants over the age of 60 were studied. Food insecurity was assessed by asking 18 questions. The sum of the 18 questions was calculated and categorized into the food security group, the early stage of food insecurity group, and the food insecurity group. Then we analyzed differences in the prevalence of dizziness between the three groups.

Results: The prevalence of dizziness was higher in the food insecurity group. Furthermore, the odds of complaining of dizziness were 1.58 times in the early stage of food insecurity group and 2.51 times in the food insecurity group compared to the food security group.

Conclusion: The study found that food insecurity increases the risk of dizziness and poses a health risk. The problem of food insecurity should not be limited to individuals, but should be managed by communities and countries. It is hoped that the results of this study will provide direction for program development and policy formulation to address food insecurity and improve health and nutritional status.

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Introduction

As the economy grows and people's interest in health increases, the absolute level of health has improved, but a new social problem is emerging: health inequality [1]. While rising income levels are reducing absolute food scarcity, there are still people who are food insecure and do not have access to enough nutritious food [2]. The United States Department of Agriculture (USDA) defines food insecurity as follows. Food insecurity is defined as economic and social conditions that limit access to enough food for all people in a household to live a healthy life [3]. Food insecurity is not just about low income or lack of food quantity, it is a multifaceted concept of food quality and access that affects physical and mental health and should be addressed [4]. As the elderly are often the first to experience food insecurity [5], this study investigated the prevalence of food insecurity among the Korean elderly. In particular, we want to determine the relationship between dizziness, one of the most common complaints in geriatric health, and food insecurity.

Dizziness and imbalance are major problems in the elderly population, and age-related vestibular loss (ARVL) occurs during the normal aging process. This is because the brain's ability to integrate and analyze visual, somatosensory, and vestibular sensations, as well as other information, declines with age [6]. Dizziness and imbalance lead to a decreased quality of life and increase the risk of falls and injuries. According to the National Institute on Deafness and Other Communication Disorders of the National Institutes of Health, falls account for more than 50% of accidental deaths in older adults [7]. Prevention and treatment strategies for these diseases are limited, but the patient's nutritional status has been identified as a modifiable risk factor.

There have been previous studies on food insecurity in Korea, but most of them have focused on the relationship with nutritional status, and there is a lack of research on the effect of food insecurity on health status. Therefore, this study aims to identify the food insecurity status of Korean elderly people aged 60 and older and analyze the relationship between food insecurity and dizziness.

Methods

This study used data from the eighth (2019-2021) of the Korea National Health and Nutrition Examination Survey (KNHANES). This data was collected by the Korea Centers for Disease Control and Prevention and consists of a household survey, a health survey, a medical examination survey, and a nutrition survey. The nutrition survey included data on dietary behavior, dietary supplements, nutritional knowledge, food intake 1 day (24-hour recall survey), and food safety survey, and was analyzed using food intake and food safety survey items. Of the 22,559 participants, a total of 3,002 (1,292 men and 1,710 women) were studied, excluding those under the age of 60 and those who did not answer the questionnaire (Figure 1.)

Food insecurity: The Korea National Health and Nutrition Examination Survey (KNHANES) data assesses food security through an 18-item questionnaire based on the U.S. Household Food Security/Hunger Survey Module and newly developed for Korean conditions. Each person in the household responds to 18 questions to represent the household's food security over the past year, with 18 questions for households with children and 10 questions for households without children. The sum of the 18 questions is calculated and scores of 0-2 are categorized as food security (FS), scores of 3-7 for households with children and 3-5 for households without children are categorized as marginal food insecurity (without hunger), scores of 8-12 for households with children and 6-8 for households without children are categorized as moderate food insecurity (with hunger), and scores of 13-18 for households with children and 9-10 for households without children are categorized as severe food insecurity (with hunger). When we examined the frequency of food insecurity among the subjects in this study, the frequency of moderate and severe food insecurity was very low, so they were combined into the food insecurity group. Finally, we categorized them into food secure group (FS), early stage food insecurity group (food insecure without hunger; FI H-), and food insecure group (food insecure with hunger; FI H+) for the final analysis.

General characteristics: The age, gender, income level, education level, smoking status, physical activity, alcohol consumption, prevalence of diabetes, hypertension, depression, stroke, and dizziness were collected from health surveys, and body mass index (BMI, kg/m^2) was measured using anthropometric data. Gender was categorized as 'male' and 'female', age was expressed as the average age of each group, education level was categorized as 'elementary school or less', 'middle school graduate', 'high school graduate', 'college graduate or higher', and income level was categorized 'Lowest', 'Medium-lowest', 'Medium-highest' and 'Highest' according to the income level classification of the National Health and Nutrition Examination Survey. Those who answered "yes" to the question "Have you ever experienced dizziness or balance problems" were categorized as complaining of subjective dizziness (Table 1).

General characteristics and nutritional status based on food insecurity: To identify clinical characteristics according to food insecurity, we analyzed differences in mean age, sex, mean BMI, income, education, smoking status, physical activity, alcohol consumption, and prevalence of diabetes, hypertension, depression, stroke, and dizziness between the FS, FI H-, and FI H+ groups (Table 2, Figure 2). Dietary intake examined by 24-hour recall to assess nutritional status in food insecurity were used to calculate total energy intake and nutrient intake of carbohydrates, protein, fat, vitamin A, vitamin B1, vitamin B2, vitamin C, niacin, calcium, phosphorus per 1,000 kcal per day (Table 3).

Statistical analysis: Since the sample design of the National Health and Nutrition Examination Survey was a two-stage stratified cluster sampling method, an analysis method reflecting complex sampling was used. The variance estimation stratum of the 8th National Health and Nutrition Examination Survey 2019-2021 was analyzed as the stratum variable, the cluster variable was the survey district, and the weights of the Health Survey & Examination Survey & Nutrition Survey were set as the sample weights. Continuous data were expressed as composite means and standard deviations, and composite analysis of variance (analysis of variance; ANOVA) was performed to determine if there were differences between groups. Categorical data were presented as weighted percentages of the population and standard errors using a composite frequency analysis, followed by a composite chi-square test to determine if there were differences between groups. Multiple logistic regression was used to determine how food insecurity was associated with dizziness. Adjusted odds ratios (AORs) for dizziness complaints are presented with 95% confidence intervals (95% CIs). To correct for the effect of each factor on the development of dizziness, Model 1 was adjusted for age and gender; Model 2 was additionally adjusted for income, education, alcohol consumption, smoking, and physical activity; Model 3 was adjusted for comorbidities of hypertension and diabetes, including the variables in Model 2; and Model 4 was adjusted for comorbidities of depression and stroke, including the variables in Model 3. A p-value less than 0.05 was considered a statistically significant difference. The data collected in this study were analyzed using R, version 4.2.2 (R Foundation for Statistical Computing, Vienna, Austria, http://www.R-project.org) and SAS version 9.3 (Statistical Analysis System, SAS Institute Inc., Cary, NC).

Results

General characteristics: The general characteristics of the study population are shown in Table 1. The average age of the 3002 seniors aged 60 and older was 69.4 years, with 94.8% in the food secure FS group and 4.1% and 1.1% in the food insecure FI H- and FI H+ groups, respectively, making up approximately 5.2% of the total sample. Dizziness was reported by 34.5% of the participants (Table 1).

General characteristics of food insecurity: The average age by food security was 69.3 years for FS, 70.3 years for FI H-, and 70.6 years for FI H+. In terms of income level, FS, FI H-, and FI H+ all had the highest proportion of people with 'low' income level, 29.6%, 68.5%, and 83.5%, respectively. In particular, the proportion of people with 'lowest' income level in FI H- was 83 (P<0.001). In terms of education level, the FS group had the highest percentage of 'elementary school or less' at 39.3%, followed by 'high school graduation' at 26%, 'middle school graduation' at 18.4%, and 'university or higher' at 16.3%. In the food insecure groups, FI H- and FI H+, the proportion of those with 'elementary school or less' was also higher in the food insecure group compared to the food secure group, at 64.4% and 67.5%, respectively (P<0.001). When analyzing the association of food security with diabetes, hypertension, and stroke, there was no significant association. When analyzing the association of food security with mental health, the prevalence of depression was 3.3% in the FS group, 7.3% in the FI H- group, and 10.9% in the FI H+ group (P<0.05). The risk of mental health increased significantly with the severity of food insecurity (Table 2). The prevalence of dizziness according to food insecurity was 33.5%, 50.4%, and 63.5% for FS, FI H-, and FI H+, respectively, indicating a higher prevalence of dizziness in the food insecure group. (P<0.001) (Figure 2).

Food insecurity and nutrient intake: Table 3 shows the percentage of energy intake and nutrient intake. In the study population of older adults aged 60 years and older, the proportion of carbohydrate intake was higher in the FI group than in the FS group, accounting for 65.6% in the FS group, 69.5% in the FI H- group, and 71.1% in the FI H+ group (P<0.001). On the other hand, the intake of nutrients such as total energy, protein, fat, vitamin A, vitamin B1, vitamin B2, vitamin C, niacin, calcium, and phosphorus were lower in the FI group compared to the FS group, showing significant differences according to the degree of food insecurity (P<0.001) (Table 3).

Association between food insecurity and dizziness: To determine the association between food safety and dizziness, odds ratios (95% CIs) and confidence intervals (CIs) were calculated, and unadjusted odds ratios were 2.02 times (95% CI 1.37-2.97) for dizziness in the FI H- group and 3.45 times (95% CI 1.69-7.05) in the FI H+ group compared to the FS group. In Model 4, adjusting for all confounders, the odds of dizziness were 1.58 times (95% CI 1.05-2.38) in the FI H- group and 2.51 times (95% CI 1.18-5.32) in the FI H+ group compared to the FS group (Table 4).

Table 1: Subject characteristics.

	Overall	Male	Female	p-value
Unweighted N	3002	1292	1710	
Age (years)	69.4 ± 6.4	69.6 ± 6.4	69.1 ± 6.4	0.063
Sex (%, SE)				
Male	45.8 (0.9)			
Female	54.2 (0.9)			
Body mass index(kg/m²)	24.3 ± 3.3	24.2 ± 3.0	24.3 ± 3.5	0.324
Household income (%, SE)				<0.001
Lowest	31.8 (1.4)	28.6 (1.6)	34.5 (1.5)	
Medium-lowest percentile	28.8 (1.1)	28.9 (1.4)	28.8 (1.2)	
Medium-highest percentile	22 (1.1)	23.2 (1.3)	21 (1.2)	
Highest	17.3 (1.2)	19.3 (1.5)	15.7 (1.2)	
Education level (%, SE)				<0.001
Elementary school or less under	40.6 (1.4)	29.3 (1.7)	50.1 (1.7)	
Middle school	18.4 (0.8)	17.7 (1.2)	18.9 (1.1)	
High school	25.4 (1)	30.7 (1.4)	20.9 (1.2)	
College or higher	15.6 (1.1)	22.3 (1.6)	10 (0.9)	
Current smoker (%, SE)	11.3 (0.8)	20.6 (1.5)	3.4 (0.6)	<0.001
Physical activity (%, SE)	35.4 (1.1)	39.2 (1.6)	32.1 (1.5)	<0.001
Alcohol drinking (%, SE)	35.8 (1.1)	56 (1.7)	18.8 (1.1)	<0.001
Diabetes (%, SE)	29.1 (1)	33 (1.6)	25.9 (1.3)	<0.001
Hypertension (%, SE)	54.8 (1.1)	53.9 (1.6)	55.6 (1.5)	0.423
Depression (%, SE)	3.5 (0.4)	2 (0.5)	4.9 (0.7)	<0.001
Stroke (%, SE)	3.7 (0.5)	4.8 (0.9)	2.8 (0.5)	0.013
Food insecurity (%, SE)				0.193
Secure	94.8 (0.5)	95.4 (0.6)	94.3 (0.7)	
Insecure without hunger	4.1 (0.4)	3.8 (0.5)	4.4 (0.5)	
Insecure with hunger	1.1 (0.2)	0.8 (0.2)	1.3 (0.2)	
Dizziness or balance disturbance (%, SE)	34.5 (1.2)	28.6 (1.6)	39.5 (1.5)	<0.001

Data was expressed as mean ± standard errors (SEs) or numbers (%) ± SEs.

Table 2: Clinical characteristics according to the household food security status in Korean adults.

		Household food security status		P-value
	Food secure	Food insecure G3		
		Without hunger	With hunger	
Unweighted N	2821	143	38	
Age (years)	69.3 ± 6.4	70.3 ± 6.5	70.6 ± 7.4	0.154
Sex (%, SE)				0.193
Male	46.1 (0.9)	41.6 (3.4)	35.6 (7.6)	
Female	53.9 (0.9)	58.4 (3.5)	64.4 (9.3)	
Body mass index (kg/m²)	24.3 ± 3.3	24.5 ± 3.6	24.3 ± 3.3	0.941
Household income				<0.001
Lowest	29.6 (1.4)	68.5 (5.4)	83.5 (10.1)	

Medium-lowest percentile	29.3 (1.1)	21 (3.7)	14.5 (4.9)	
Medium-highest percentile	22.9 (1.1)	8.2 (2.2)	2 (0.9)	
Highest	18.2 (1.3)	2.3 (0.7)	0 (0)	
Education level (years)				<0.001
Elementary school or less under graduate	39.3 (1.4)	64.4 (5.6)	67.5 (11.3)	
Middle school	18.4 (0.8)	17.8 (3.2)	14.7 (4.7)	
High school	26 (1.1)	13.8 (2.7)	15.5 (5)	
College or higher	16.3 (1.1)	4 (1.5)	2.3 (1.1)	
Current smoking (%)	10.9 (0.8)	17.4 (4)	23.5 (10.9)	0.009
Physical activity (%)	35.7 (1.2)	28.9 (4.3)	32.7 (11.3)	0.284
Alcohol drinking (%)	36.1 (1.1)	29 (4.3)	36.9 (10.6)	0.256
Diabetes (%)	28.9 (1.1)	31.8 (4.4)	36.7 (11)	0.501
Hypertension (%)	54.5 (1.2)	60.1 (4.2)	57.2 (9.6)	0.467
Depression (%)	3.3 (0.4)	7.3 (3.2)	10.9 (10.8)	0.004
Stroke (%)	3.6 (0.5)	5.1 (3.1)	8 (8.9)	0.292

Table 3: Nutritional status according to household food security.

	Household food security status			P-value
	Food secure	Food insecure G3		
		Without hunger	With hunger	
Total calories (kcal/day)	1,658.9 ± 650.1	1,413.0 ± 568.1	1,260.0 ± 526.1	<0.001
Carbohydrate (%)	65.6 ± 11.7	69.5 ± 10.8	71.1 ± 9.4	<0.001
Protein (%)	14.4 ± 3.7	13.3 ± 3.8	11.9 ± 3.2	<0.001
Fat (%)	7.9 ± 3.7	6.8 ± 3.4	6.6 ± 3.4	<0.001
MUFA (%)	10.7 ± 9.0	7.2 ± 6.1	6.6 ± 5.6	<0.001
PUFA (%)	9.9 ± 7.1	6.7 ± 5.0	6.7 ± 5.0	<0.001
Saturated fatty acid (%)	10.2 ± 7.8	7.9 ± 6.1	7.3 ± 6.5	<0.001
Vitamin A (μg RE/day)	359.5 ± 314.2	247.5 ± 304.6	178.9 ± 137.7	<0.001
Vitamin B1 (mg/day)	1.1 ± 0.6	0.9 ± 0.6	0.7 ± 0.3	<0.001
Vitamin B2 (mg/day)	1.4 ± 0.7	1.0 ± 0.6	1.1 ± 0.8	<0.001
Vitamin C (mg/day)	66.5 ± 75.0	42.0 ± 40.2	54.4 ± 112.4	<0.001
Niacin (mg/day)	10.6 ± 5.9	8.1 ± 4.6	6.7 ± 3.8	<0.001
Calcium (mg/day)	492.2 ± 289.0	384.0 ± 234.0	324.7 ± 237.7	<0.001
P (mg/day)	983.6 ± 443.4	766.6 ± 344.5	647.7 ± 357.7	<0.001

*Percentages are intake (g) X 4 kcal (in case of carbohydrate and protein) or 9 kcal (in case of fats) /total calorie intake X 100; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; RE, retinol equivalents.
Data was expressed as mean ± standard errors (SE) for categorical variables.

Table 4: Odds ratios (95% CIs) for dizziness or balance disturbance according to household food security status in Korean older adults.

| | Household food security status | | |
| | Food secure | Food insecure | |
		Without hunger	With hunger
Unadjusted	ref	2.02 (1.37, 2.97)	3.45 (1.69, 7.05)
Model 1	ref	1.93 (1.3, 2.87)	3.23 (1.52, 6.89)
Model 2	ref	1.61 (1.07, 2.43)	2.61 (1.22, 5.61)
Model 3	ref	1.61 (1.07, 2.43)	2.65 (1.23, 5.67)
Model 4	ref	1.58 (1.05, 2.38)	2.51 (1.18, 5.32)

Model 1: Age, sex.
Model 2: Age, sex, household income, education, alcohol drinking, smoking, exercise
Model 3: Age, sex, household income, education, alcohol drinking, smoking, exercise, HTN, DM.
Model 4: Age, sex, household income, education, alcohol drinking, smoking, exercise, HTN, DM, Depression, stroke.

Discussion

This study was conducted to determine the prevalence of food insecurity among the elderly aged 60 years and older using data from the 8th National Health and Nutrition Examination Survey (2019-2021) and to investigate the effects of food insecurity on dizziness. Although there are differences in the measurement tools and analyses of food insecurity among studies, this study used the food security questionnaire from the Korea Health and Nutrition Examination Survey. We focused on the elderly, who are the first to experience food insecurity in their households, and categorized a total of 3002 people into three groups according to food insecurity. Most of the studies related to food insecurity in Korea have analyzed its relationship with dietary intake and nutritional status, and some have analyzed its relationship with chronic diseases and mental health conditions, but there is a lack of research on its relationship with dizziness [8]. It is important to note that the prevalence of dizziness in this study was calculated using real clinical data. When analyzing the relationship between food insecurity and dizziness, the prevalence of dizziness was 33.5%, 50.4%, and 63.5% in the FS, FI H-, and FI H+ groups, respectively, and the odds of complaining of dizziness were 1.58 times higher in the FI H- group and 2.51 times higher in the FI H+ group compared to the FS group, confirming that food insecurity is a factor in causing and maintaining dizziness.

Poor dietary quality due to food insecurity increases the risk of diseases caused by poor nutrition. In particular, the prevalence of anemia tended to be higher in the food insecurity group than in the food security group, which can lead to dizziness [9]. Also studies have shown that increased carbohydrate and sugar intake and insufficient protein intake lead to adverse effects in the inner ear, which are positively correlated with vestibular dysfunction [10,11,12]. On the other hand, the Mediterranean diet, which includes whole grains, olive oil, fruits, vegetables, beans, and nuts, has been reported to lower the risk of vestibular damage [13,14]. This is because the Mediterranean diet's anti-inflammatory and antioxidant properties inhibit age-related damage to the vestibular system [15,16]. In addition, vitamins A, C, and E have been shown to act as antioxidants, reducing the risk of age-related vestibular loss [17-19]. Other studies have also shown that vitamin D deficiency may be a risk factor for benign paroxysmal positional vertigo [20]. Vit D deficiency can alter the chemical composition of the otolith by downregulating the calcium binding protein system [21,22]. As a result, the dolomite becomes brittle, and dolomite that favors the nymphs can cause dizziness [23]. As such, certain nutrient deficiencies are associated with an increased risk of dizziness. Further research is needed to understand the pathophysiologic mechanisms of nutrient deficiencies that lead to dizziness.

A limitation of this study is the limited nature of the dizziness questionnaire. In this study, subjects who answered 'yes' to the questionnaire about whether they had ever experienced dizziness or balance problems were classified as complaining of dizziness. However, people describe dizziness in a variety of ways, including 'spinning', 'pinging', 'fainting', 'falling to one side' and 'dizzy'. Dizziness is a complex symptom that can be caused by a malfunction in any one of the visual, vestibular, somatosensory, and central nervous systems that are required to maintain equilibrium in the body [24,25]. Therefore, a simple questionnaire is not sufficient to determine the prevalence of dizziness. In fact, it is difficult to diagnose dizziness because there are too many diagnoses to differentiate between peripheral vestibular diseases such as benign paroxysmal positional vertigo, vestibular neuritis, and Meniere's disease, central vestibular diseases caused by cerebellar artery infarction, and syncopal dizziness caused by reduced cerebral blood flow [26]. A limitation of this study is that the subjects were not asked about dizziness in depth. If food insecurity leads to dizziness, further research is needed to identify patterns of dizziness. In addition, this study was a cross-sectional analysis, so the cause-and-effect relationship is not clear. As dizziness is a long-term accumulation of health behaviors, cross-sectional studies are limited in their ability to identify causal relationships with food insecurity. However, it is noteworthy that the increased risk of dizziness was found even after adjusting for confounders such as gender, age, income, education, alcohol consumption, smoking, physical activity, hypertension, diabetes, depression, and stroke. One significant limitation is the lack of assessment of medication history, particularly in relation to drugs that can induce dizziness. Numerous medications, including antihypertensives, drugs for benign prostatic hyperplasia, sedatives, analgesics, and others, are associated with dizziness. Investigation into this aspect is anticipated to enhance the comprehensiveness of the study.

Despite the above limitations, this study used data from the National Health and Nutrition Examination Survey, a reliable and representative national survey, to determine the prevalence of food insecurity in the Korean elderly and found that food insecurity is a factor that exacerbates dizziness. Consistent with previous studies reporting an association between education and food insecurity [27], we found that the highest proportion of the food insecure group had "elementary school or less" education. Income level was also associated with higher levels of food insecurity, which is consistent with studies reporting that higher levels of food insecurity are associated with lower monthly household income and lower socioeconomic status [28]. This suggests that income level is a barrier to food insecurity and is most prevalent among lower income groups. The problem of food insecurity should not be limited to individuals, but should be managed by the community and the state together. And support for low-income people and the elderly who are predicted to be food insecure should be continued. Nutrition programs such as the free meals for the elderly provided by local governments and the Nutrition Plus program of the Minis-

try of Health and Welfare should continue to operate. These programs should be supplemented with nutrition education to help them make healthy food choices. In addition, the elderly with food insecurity should be considered as a risk group for falls due to dizziness, and interventions such as regular exercise education and home health care are needed. The findings of this study may provide direction for program development and policy formulation to address food insecurity and improve physical and mental health and nutritional status.

Conclusion

The significance of this study is that the food security status of the elderly aged 60 years and older in Korea was calculated using data from the National Health and Nutrition Examination Survey and the correlation with dizziness was analyzed. The results showed that food insecurity increases the risk of dizziness and poses a health risk. Therefore, communities should establish intervention programs to manage high-risk groups to promote health and contribute to health equity.

Declarations

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