

# Food literacy as a moderator in the relationship between food security and dietary diversity among adults in Seoul: Based on the 2021–2023 Seoul Food Statistics Survey

**Background:** Food literacy (FL) and food security are key factors influencing healthy eating and dietary diversity. This study examined whether FL moderates the relationship between food security and dietary diversity score (DDS) among adults in Seoul.

**Methods:** Data were obtained from the 2021–2023 Seoul Food Statistics Survey and included 8,248 adults aged 18–64 years. The DDS was calculated based on daily intake from five food groups (0–5 points). Food security was classified as secure or insecure. FL was assessed using a 33-item scale across nutritional and safety, cultural and relational, and socioecological domains. Participants were grouped into three FL levels. Chi-square tests, t-tests, analysis of variance, and logistic regression were performed.

**Results:** Food-secure participants had significantly higher DDS (2.47 vs. 2.22,  $P < 0.001$ ) and FL scores (64.03 vs. 60.85,  $P < 0.001$ ), including all subdomains. The DDS gap between the secure and insecure groups was the largest among those with low FL (2.32 vs. 1.74,  $P < 0.001$ ), narrowing with higher FL. A significant interaction was found between FL and food security on DDS ( $P$  for interaction  $< 0.001$ ). After adjusting for confounders, the highest FL group had greater odds of high DDS (OR 2.12, 95% CI 1.84–2.43,  $P < 0.001$ ).

**Discussion and conclusion:** FL moderates the relationship between food security and dietary diversity and may buffer the negative effects of food insecurity. FL education may improve diet quality, particularly in food-insecure populations.

**Keywords:** food security, food literacy, dietary diversity, nutrition equity

## *Introduction*

In modern society, many adults face challenges in maintaining a nutritionally balanced diet due to irregular eating habits, heavy reliance on processed and delivered foods, and frequent consumption of meals outside the home [1, 2]. These patterns have been identified as major contributors to chronic diseases such as hypertension, obesity, and diabetes [3]. Such dietary risks are even more pronounced in vulnerable groups, including low-income individuals, older adults, and single-person households, who often face constraints in time, budget, and access to reliable dietary information [4, 5].

Among these, food security, dietary diversity, and food literacy have emerged as critical components. In particular, food security has gained prominence as it addresses the structural and environmental conditions that enable or hinder healthy eating [6, 7]. According to the Food and Agriculture Organization (FAO), food security is a condition in which all people, at all times, have physical and economic access to sufficient, safe, and nutritious food that meets their dietary preferences for an active and healthy life [8]. Individuals with low food security often rely on low-cost, high-calorie foods because of economic limitations, leading to nutrient imbalances and deficiencies [9, 10]. Conversely, those with high food security more often consume nutrient-dense foods such as vegetables, fruits, and dairy products, invest more resources in meal preparation, and exhibit better overall diet quality and health outcomes [11, 12]. However, studies on the relationship between food security and dietary behavior have largely focused on low-income and vulnerable populations, and relatively few studies have targeted the general adult population [13, 14].

The dietary diversity score (DDS) quantifies the quality of a person's diet by measuring whether various major food groups are consumed over a certain period [15]. Compared with indicators that focus on individual foods or specific nutrients, the DDS reflects the balance and variety of a diet and can predict the risk of nutritional deficiencies and chronic diseases [16, 17]. Studies have shown that higher DDS is associated with increased intake of essential nutrients, such as dietary fiber, vitamins, and minerals, and is significantly linked to health perception and mental well-being [18, 19].

In situations where individuals cannot access diverse foods owing to economic or information barriers, food literacy (FL) has gained attention as a personal capability of improving diet quality [20, 21]. Based on health literacy, FL encompasses the knowledge, skills, and attitudes necessary to practice healthy eating habits [22]. According to the 2023 Seoul Food Statistics Survey, FL includes the ability to select and manage food for survival and healthy life, cooking skills, and understanding the cultural, communal, agricultural, and ecological values of food. It is categorized into nutrition and safety, culture and relationships, and socioecological dimensions [23]. FL allows the selection of healthy food even in limited-access environments, and higher FL levels are associated with better diet quality, increased dietary diversity, and favorable outcomes related to obesity and mental health [24-26]. Conversely, low FL is linked to greater consumption of processed foods and higher risks of nutritional imbalance and health issues [27, 28].

Although some studies have explored the relationship between food security and FL and between the DDS and FL, very few studies have analyzed the effect between food security and DDS depending on the FL level. Therefore, the present study aimed to identify FL levels, food security, and DDS distribution among Seoul citizens using data from the 2021–2023 Seoul Food Statistical Survey and analyze differences in the relationship between food security and DDS based on the FL level.

## *Methods*

### *1. Study participants and data collection procedure*

To analyze the dietary characteristics of adults in Seoul, this study used data from the Seoul Food Statistics Survey collected between 2021 and 2023 [23]. This survey is nationally approved statistics that has been conducted annually by the Seoul Metropolitan Government from 2020 to 2023 and provides foundational data to comprehensively understand food-related issues among Seoul citizens [28, 29]. The study participants were adults aged 18–64 years, and the sample was selected using a stratified cluster sampling method. The survey was conducted by trained interviewers from K-Stat, a professional survey agency that visited sample households and collected responses using a structured questionnaire. Data collection was conducted from September 13 to October 29, 2021, from July 11 to August 12, 2022, and from September 8 to October 13, 2023. All participants were provided gift vouchers as compensation for survey participation. The survey was approved by the Institutional Review Board of Dankook University (DKU 2020-01-006) and the Public Institutional Review Board (P01-202309-01-004) and was conducted after obtaining written informed consent from the participants. To ensure the reliability of the analysis, the data cleaning process, responses with inconsistencies between major variables, or missing responses were excluded.

### *2. Key measures in the study*

#### *(1) Sociodemographic characteristics*

Sex, age, educational attainment, household type, occupation, average monthly household income, subjective health status, and food security status were collected as sociodemographic characteristics, and each variable was recategorized for statistical analysis. Age was classified into groups aged 18–34, 35–49, and 50–64 years. Educational attainment was dichotomized into high school graduate or lower and college entrance or higher. The household type was categorized into single-person households, couple households, households with two or more generations, and other households. Subjective health status was classified into poor, average, and good. Food security status was assessed based on the question, “Which of the following best describes your food situation in the past year?” Among the response options, “I was able to eat sufficient quantity and a variety of foods” was classified as the food-secure group, whereas “I was able to eat sufficient quantity of food but not always a variety” or “I was not able to eat sufficient food” were classified as the food-insecure group [30].

#### *(2) Dietary diversity score (DDS)*

The DDS was calculated based on food consumption frequency data collected from the Seoul Food Statistics Survey conducted between 2021 and 2022. In this study, one point was assigned for the daily intake of each of the following five food groups: whole grains, vegetables, fruits, protein foods, and dairy products, and the DDS was calculated by summing these points [15]. Whole grains included whole and mixed grains, and vegetables included raw, seasoned, and kimchi. Fruits were composed of fresh fruits and canned fruits, and the protein food group included red meat, processed meat, fish, eggs, beans, and tofu. The dairy group included milk, yogurt, and cheese [31]. Even if multiple items were consumed within the same food group, no duplicate points were awarded, and the internationally accepted DDS calculation standard was used. The DDS ranged from 0 to 5 points; in this study, it was recategorized as a binary variable [32]. A score of  $\geq 3$  was classified as “high DDS,” whereas a score of  $\leq 2$  as “low DDS.” This criterion reflects the average DDS of the total sample

(approximately 2.4 points) and regards the intake of at least three major food groups as the minimum standard for dietary diversity [18].

### ***(3) Food literacy (FL)***

FL consisted of 33 items and was evaluated based on nutrition and safety, culture and relationships, and socioecological domains [21]. The nutrition and safety domain consisted of 14 items and assessed participants' ability to acquire, understand, and use food and cooking information. The culture and relationships domain included eight items related to interest and understanding food culture, pursuit of enjoyment and meaning through food, gastronomic interest, and promotion of community and well-being. The socioecological domain comprised 11 items that evaluated participants' ability to understand and prioritize the social and ecological consequences of their food choices. All items were evaluated using a 5-point Likert scale ranging from "strongly disagree" to "strongly agree." The score for each domain was converted to a scale of 100 points by multiplying the mean item score by 5, and the total FL score was calculated as the average of three domain scores. Based on this score, the FL level was categorized into low, moderate, and high groups and used in the analysis.

### ***3. Statistical analysis***

Chi-square tests were conducted to examine group differences according to the sociodemographic characteristics. Differences in the mean FL and DDS according to the food security status were assessed using Student's t-test. To explore whether the relationship between food security and DDS varied according to FL level, analysis of variance was performed to examine interaction effects. In addition, logistic regression analysis was conducted to assess the effect of food security on the DDS, and the results are reported as odds ratios (ORs) with 95% confidence intervals (CIs). Model 1 was adjusted for sex, age, educational attainment, household type, occupation, average monthly household income, and subjective health status. Model 2 added food security status to model 1. Model 3 added the FL score to model 2 to analyze how the relationship between food security and DDS differed depending on the FL level. All statistical analyses were performed using STATA 17.0 (StataCorp LLC, College Station, TX, USA), and significance was set at  $P < 0.05$ .

## Results

### 1. Sociodemographic characteristics by sex

**Table 1** presents the sociodemographic characteristics by sex. Among a total of 8,248 participants, 3,744 (45.4%) were men, and 4,504 (54.6%) were women. Significant differences were observed by sex in age, educational attainment, household type, occupation, average monthly household income, subjective health status, and food security status. Regarding age groups, the proportions of participants aged 18–34 (22.1%) and 50–64 (44.1%) years were higher among women, whereas the proportion of those aged 35–49 years (38.3%) was higher among men ( $P < 0.001$ ). Regarding education level, 41.1% of women had finished high school education or lower, which was higher than 24.2% among men. Conversely, 75.8% of men had taken at least a college entrance, showing a higher proportion than women ( $P < 0.001$ ). In terms of household type, a higher proportion of women belonged to single-person (13.5%) and couple-only (29.8%) households, whereas a higher proportion of men lived in households with two or more generations (61.8%) ( $P < 0.001$ ). In terms of occupation, men were more likely to have professional (53.5%) and manual (14.1%) jobs, whereas women were more frequently employed in service/sales occupations (34.9%) and as homemakers (27.6%) ( $P < 0.001$ ). In the income category, a higher proportion of women (2.4%) earned  $< 2$  million KRW, whereas a higher proportion of men (19.4%) earned  $\geq 7$  million than women (16.9%) ( $P < 0.001$ ). Regarding subjective health status, the proportion of respondents who responded “good” was higher among men (83.4%) than among women (80.1%) ( $P = 0.032$ ). The food-secure group included a higher proportion of men (76.5%) than women (73.4%) ( $P = 0.015$ ).

### 2. Dietary diversity score and food literacy by sociodemographic characteristics

**Table 2** presents the results of the comparison of the mean DDS and FL scores according to sociodemographic characteristics. By sex, women showed significantly higher DDS (2.45 vs. 2.35,  $P < 0.001$ ) and FL scores (66.11 vs. 59.77,  $P < 0.001$ ) than men. Participants aged 50–64 years had higher DDS than those aged 18–34 (2.47 vs. 2.35) and 35–49 (2.47 vs. 2.36) years ( $P = 0.002$ ). Regarding FL, the highest score was observed in the group aged 35–49 years, whereas the lowest was in the group aged 18–34 years (64.01 vs. 61.65,  $P = 0.008$ ). Among educational levels, those with a high school education or lower showed a higher DDS than those had taken college entrance or higher (2.45 vs. 2.39,  $P = 0.032$ ), whereas their FL score was lower (64.05 vs. 62.82,  $P < 0.001$ ). By household type, participants from households with two or more generations had significantly higher DDS (2.46 vs. 2.04,  $P = 0.006$ ) and FL scores (63.50 vs. 58.88,  $P = 0.003$ ) than those from other household types. Among occupations, homemakers had the highest DDS (2.51,  $P = 0.003$ ) and FL score (68.25,  $P < 0.001$ ). Regarding household income, those earning 5–7 million KRW showed higher DDS (2.49 vs. 2.09,  $P = 0.004$ ) and FL scores (63.72 vs. 61.59,  $P = 0.008$ ) than those earning  $< 2$  million KRW. For subjective health status, participants who responded “good” had significantly higher DDS (2.43 vs. 2.33,  $P = 0.001$ ) and FL scores (64.16 vs. 56.65,  $P = 0.042$ ) than those who responded, “not good.” Additionally, participants in the food-secure group showed significantly higher DDS (2.47 vs. 2.22,  $P < 0.001$ ) and FL scores (64.03 vs. 60.85,  $P < 0.001$ ) than those in the food-insecure group.

### 3. Food literacy and dietary diversity score by food security status

**Table 3** presents the results of comparing the mean FL scores and DDS according to food security status. After

adjusting for sex, age, educational attainment, household type, occupation, average monthly household income, and subjective health status, the food-secure group showed significantly higher scores in all FL subdomains (nutrition and safety, culture and relationships, and socioecological domain) and in the total FL score ( $P < 0.001$ ). In the nutrition and safety domain, the food-secure group scored 65.07, whereas the food-insecure group scored 64.02 ( $P < 0.001$ ). In the culture and relationships domain, the scores were 61.96 and 58.21, respectively, showing higher values for the food-secure group ( $P < 0.001$ ). In the socioecological domain, the food-secure group scored 64.28, compared with 62.66 in the food-insecure group ( $P < 0.001$ ). The total FL score was also significantly higher in the food-secure group (63.77) than in the food-insecure group (61.63), indicating that the food-secure group showed significantly higher FL scores across all domains ( $P < 0.001$ ). In addition, the DDS was significantly higher in the food-secure group (2.46) than in the food-insecure group (2.24) ( $P < 0.001$ ).

#### **4. Dietary diversity score by food literacy level and food security status**

**Table 4** presents the results of comparing the relationship between food security status and DDS according to the FL level. After adjusting for sex, age, educational attainment, household type, occupation, average monthly household income, and subjective health status, a significant interaction effect between the FL level and the relationship between food security status and DDS was observed ( $P$  for interaction  $< 0.001$ ). In the high FL group, the food-insecure group had a higher DDS than the food-secure group (2.55 vs. 2.44,  $P = 0.017$ ). In the moderate FL group, the food-secure group had a significantly higher DDS than the food-insecure group (2.40 vs. 2.21,  $P < 0.001$ ). In the low FL group, the DDS was also significantly higher in the food-secure group than in the food-insecure group (2.32 vs. 1.74,  $P < 0.001$ ). Moreover, as the FL level decreased, the gap in the DDS between the food-secure and insecure groups became more pronounced.

#### **5. Factors associated with high dietary diversity score**

**Table 5** presents the results of logistic regression analysis to identify factors associated with high DDS. In model 1, sex, age, educational level, household type, occupation, monthly household income, and subjective health status were included. The results showed that women were significantly more likely to have high DDS than men (OR = 1.25, 95% CI 1.13–1.38,  $P < 0.001$ ), and adults aged 35–49 years were less likely to have high DDS than those aged 18–34 years (OR = 0.86, 95% CI: 0.76–0.99,  $P = 0.030$ ). Regarding household type, couple-only households (OR = 1.39, 95% CI 1.17–1.66,  $P < 0.001$ ) and households with two or more generations (OR = 1.68, 95% CI 1.42–2.00,  $P < 0.001$ ) were more likely to have a high DDS than single-person households. Participants in service/sales occupations also had higher odds of high DDS than professionals (OR = 1.15, 95% CI 1.01–1.29,  $P = 0.030$ ). Furthermore, those with a monthly household income of 5–7 million KRW were significantly more likely to have a high DDS than those earning <2 million KRW (OR = 1.46, 95% CI 1.02–2.08,  $P = 0.036$ ). In model 2, food security status was added to the variables in model 1. The results remained consistent with model 1, and food-secure group had significantly higher odds of achieving a high DDS than the food-insecure group (OR = 1.36, 95% CI 1.23–1.52,  $P < 0.001$ ). In model 3, the total FL score was calculated by dividing it into quartiles (Q1–Q4). As a result, sex, which was significant in model 1, was no longer significant (OR = 1.10, 95% CI 0.99–1.22,  $P = 0.072$ ). However, other variables, such as age, household type, and occupation, maintained similar associations with high DDS, as in model 2. The food security status also remained a significant factor. Notably, higher FL levels were significantly associated with a greater likelihood of having a high DDS. Compared with the lowest FL quartile (Q1), the odds ratios for

high DDS increased progressively across Q2 (OR = 1.45, 95% CI 1.28–1.65,  $P < 0.001$ ), Q3 (OR = 1.52, 95% CI 1.33–1.73,  $P < 0.001$ ), and Q4 (OR = 2.12, 95% CI 1.84–2.43,  $P < 0.001$ ).

### ***Discussion***

This study examined the association between food security and DDS among adults residing in Seoul and explored how this relationship differs according to FL levels. Among a total of 8,248 participants, the food-secure group exhibited significantly higher DDS (2.47 vs. 2.22,  $P < 0.001$ ) and FL scores (64.03 vs. 60.85,  $P < 0.001$ ) than the food-insecure group. Notably, the food-secure group had significantly higher scores across all FL subdomains and the total FL score ( $P < 0.001$ ), and their DDS was also higher than that of the food-insecure group (2.46 vs. 2.24,  $P < 0.001$ ). Furthermore, the difference in the DDS according to food security status was the greatest in the low FL group, with a significant interaction effect ( $P$  for interaction  $< 0.001$ ). Logistic regression analysis also showed that higher FL levels were significantly associated with increased odds of achieving a high DDS. Specifically, individuals in the highest FL quartile (Q4) had more than twice the odds of attaining a high DDS compared to those in the lowest quartile (Q1), with an odds ratio (OR) of 2.12 (95% CI: 1.84–2.43,  $P < 0.001$ ). These findings suggest that FL plays a moderating role in helping individuals maintain dietary diversity and mitigate declines in dietary quality, even under conditions of limited food security.

Significant differences were observed by sex in terms of age, educational attainment, household type, occupation, monthly household income, subjective health status, and food security status. Relatively higher proportions of women were  $\geq 50$  years old, had educational level of high school or low, lived in single-person households, and worked as service/sales workers and homemakers. Conversely, men comprised a higher proportion of professionals and high-income earners. These results are consistent with the findings of previous studies suggesting that women are more likely to engage in caregiving roles or informal economic activities and are more vulnerable to dietary instability and social isolation because of the higher prevalence of single-person households among women [33, 34]. Furthermore, women tend to become more health conscious with age and more responsive to seeking health information and modifying dietary habits [35]. Conversely, although men generally have higher levels of labor force participation, occupational status, and income, their interest in nutrition and adherence to health-promoting behaviors are lower than those of women [36, 37]. In this study, men demonstrated higher food security than women, indicating that economic and social factors may influence food security and dietary stability [38].

The food-secure group had a significantly higher DDS than the food-insecure group, indicating the positive influence of food security on dietary diversity [39]. According to FAO, food insecurity leads to a decline in meal quality and, over the long term, may result in nutritional imbalance and deteriorating health [8, 40]. Previous studies have found that individuals with low food security tend to rely more on energy-dense but nutrient-poor processed foods because of limited food choices, with lower intake of vegetables and fruits [10, 41]. This trend may be attributed to financial constraints or limited physical access, which hinder the stable acquisition of fresh and nutritious foods, thereby reducing the intake of diverse food groups and overall dietary diversity [42, 43]. In contrast, food-secure individuals are more likely to have consistent access to sufficient and safe food and can prepare meals that include various food groups, such as vegetables, fruits, and dairy products, resulting in better overall diet quality [11, 12]. These findings suggest that food security encompasses not only physical access to food but also the resources and capacities that enable individuals to consistently obtain and utilize various foods, thereby contributing to the improvement of dietary quality.

Higher FL levels were associated with a significantly greater likelihood of achieving a higher DDS, with individuals in the highest FL quartile (Q4) being 2.12 times more likely to have a high DDS than those in the lowest quartile (Q1). Logistic regression analysis also confirmed that greater FL significantly increased the likelihood of consuming various food groups, indicating that FL presents not only as knowledge about food but also as a practical competency encompassing meal planning and food preparation [26, 44]. Previous studies have shown that individuals with higher FL tend to exhibit more proactive behaviors in meal planning and food choices and are more likely to maintain healthy dietary practices even under food-insecure conditions by utilizing various food groups [22, 45]. These findings suggest that FL contributes to improving meal quality and dietary diversity while also mitigating the limitations posed by restricted food access [46]. Therefore, enhancing FL through community-based nutrition education can strengthen individuals' ability to create balanced meals and improve the overall quality of their diet [47, 48].

This study has several limitations. First, owing to the cross-sectional design of the survey, establishing causal relationships between variables is difficult. Second, both FL and DDS were assessed using self-reported measures, which may be subject to recall or social desirability bias. To mitigate such bias, the survey was conducted anonymously, and participants were assured of confidentiality to encourage honest responses. Additionally, standardized and validated questionnaires were used where possible, which can enhance the reliability of self-reported data. Nevertheless, some degree of measurement bias may remain. Third, the study population was limited to residents of Seoul; thus, the findings may not be generalizable to other regions or countries. Fourth, although DDS is a useful indicator of dietary diversity, it does not necessarily reflect overall dietary quality. Some studies have suggested that higher DDS may also be associated with increased intake of saturated fats and sugars, indicating the need for caution when interpreting DDS results and for further research in this area [31, 49].

Future studies should design and quantitatively evaluate effective intervention strategies to improve FL. Currently, several local governments, including the Seoul Metropolitan Government, implement food assistance programs to enhance food security. Integrating FL education into these programs may contribute to more positive outcomes by enhancing individuals' food selection and preparation skills [50]. Therefore, the development and evaluation of integrated programs that combine food assistance with FL education are needed. This study found evidence suggesting a moderating effect of FL on the relationship between food security and dietary diversity among adults. As FL levels increased, the gap in the DDS between the food-secure and food-insecure groups tended to narrow, indicating that FL may help mitigate declines in dietary quality. However, due to the cross-sectional nature of the study, causal relationships cannot be confirmed. In Korea, very few studies have comprehensively examined the interaction between food security, FL, and DDS, and this study provides empirical evidence that holds both academic and policy implications.

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**Table 1.** Sociodemographic characteristics based on sex, n(%)

Variables		Total (n=8,248)		Male (n=3,744)		Female(n=4,504)		P-value *
Age groups (years)								
	18-34	1,664	(20.2)	669	(17.9)	995	(22.1)	<0.001
	35-49	2,958	(35.9)	1,434	(38.3)	1,524	(33.8)	
	50-64	3,626	(44.0)	1,641	(43.8)	1,985	(44.1)	
Education attainments								
	High school graduates	2,760	(33.5)	907	(24.2)	1,853	(41.1)	<0.001
	More than college entrance	5,488	(66.5)	2,837	(75.8)	2,651	(58.9)	
Household types								
	Single-person households	869	(10.5)	263	(7.0)	606	(13.5)	<0.001
	Couple-only households	2,482	(30.1)	1,141	(30.5)	1,341	(29.8)	
	Households with 2 generations	4,819	(58.4)	2,315	(61.8)	2,504	(55.6)	
	Others	78	(1.0)	25	(0.7)	53	(1.2)	
Occupations								
	Professionals	3,397	(41.2)	2,003	(53.5)	1,394	(31.0)	<0.001
	Service/Sales	2,593	(31.4)	1,022	(27.3)	1,571	(34.9)	
	Manual workers	645	(7.8)	527	(14.1)	118	(2.6)	
	Students	283	(3.4)	138	(3.7)	145	(3.2)	
	Homemakers	1,254	(15.2)	13	(0.4)	1,241	(27.6)	
	Unemployed/Others	76	(0.9)	41	(1.1)	35	(0.8)	
Monthly household income (KRW) <sup>1)</sup>								
	< 2 million	160	(1.9)	50	(1.3)	110	(2.4)	<0.001
	2–3.5 million	1,478	(17.9)	566	(15.1)	912	(20.3)	
	3.5–5 million	2,323	(28.2)	1,073	(28.7)	1,250	(27.8)	
	5–7 million	2,803	(34.0)	1,330	(35.5)	1,473	(32.7)	
	≥ 7 million	1,484	(18.0)	725	(19.4)	759	(16.9)	
Subjective health status								
	Not good	175	(2.1)	68	(1.8)	107	(2.4)	0.032
	Moderate	1,345	(16.3)	554	(14.8)	791	(17.6)	
	Good	6,728	(81.6)	3,122	(83.4)	3,606	(80.1)	
Food security status <sup>2)</sup>								
	Secured	6,167	(74.8)	2,863	(76.5)	3,304	(73.4)	0.015
	Insecured	2,081	(25.2)	881	(23.5)	1,200	(26.6)	

n (%).

\* P-values indicate statistical significance at  $P < 0.05$ .<sup>1)</sup> KRW: Korean Won.<sup>2)</sup> Food security status is defined as food secured when both food quantity and quality are sufficient and as food insecure when either or both are insufficient.

**Table 2.** Comparison of dietary diversity score and food literacy score by sociodemographic characteristics

Variable categories		DDS score				FL score			
		Mean	±	SD	<i>P</i> -value*	Mean	±	SD	<i>P</i> -value*
Sex	Male	2.35	±	0.02	<0.001	59.77	±	0.16	<0.001
	Female	2.45	±	0.02		66.11	±	0.13	
Age groups (years)	18-34	2.35	±	1.26 <sup>a</sup>	0.002	61.65	±	10.02 <sup>a</sup>	0.008
	35-49	2.36	±	1.20 <sup>a</sup>		64.01	±	9.29 <sup>b</sup>	
	50-64	2.47	±	1.26 <sup>b</sup>		63.32	±	9.80 <sup>c</sup>	
Education attainments	High school graduates	2.45	±	0.02	0.032	64.05	±	0.18	<0.001
	More than college entrance	2.39	±	0.02		62.82	±	0.13	
Household types	Single-person households	2.17	±	1.21 <sup>a</sup>	0.006	62.88	±	9.52 <sup>a</sup>	0.003
	Couple-only households	2.39	±	1.24 <sup>b</sup>		62.97	±	9.64 <sup>a</sup>	
	Households with 2 generations	2.46	±	1.24 <sup>b</sup>		63.50	±	9.73 <sup>a</sup>	
	Others	2.04	±	1.27 <sup>a</sup>		58.88	±	10.66 <sup>b</sup>	
Occupations	Professionals	2.33	±	1.22 <sup>a</sup>	0.003	62.58	±	9.39 <sup>a</sup>	<0.001
	Service/Sales	2.45	±	1.26 <sup>ab</sup>		63.80	±	9.24 <sup>b</sup>	
	Manual workers	2.40	±	1.18 <sup>ab</sup>		58.29	±	9.33 <sup>c</sup>	
	Students	2.43	±	1.30 <sup>ab</sup>		56.15	±	11.53 <sup>c</sup>	
	Homemakers	2.51	±	1.24 <sup>b</sup>		68.25	±	8.13 <sup>d</sup>	
	Unemployed/Others	2.62	±	1.19 <sup>b</sup>		58.17	±	13.59 <sup>c</sup>	
Monthly household income (KRW) <sup>3)</sup>	< 2 million	2.09	±	1.15 <sup>a</sup>	0.004	61.59	±	8.66 <sup>a</sup>	0.008
	2-3.5 million	2.32	±	1.26 <sup>ab</sup>		61.90	±	9.55 <sup>b</sup>	
	3.5-5 million	2.40	±	1.21 <sup>ab</sup>		62.86	±	9.30 <sup>c</sup>	
	5-7 million	2.49	±	1.25 <sup>b</sup>		63.72	±	9.68 <sup>cd</sup>	
	≥ 7 million	2.38	±	1.25 <sup>ab</sup>		64.39	±	10.42 <sup>d</sup>	
Subjective health status	Not good	2.33	±	1.27 <sup>a</sup>	0.001	56.65	±	10.49 <sup>a</sup>	0.042
	Moderate	2.32	±	1.25 <sup>a</sup>		59.45	±	9.10 <sup>b</sup>	
	Good	2.43	±	1.23 <sup>b</sup>		64.16	±	9.55 <sup>c</sup>	
Food security status <sup>4)</sup>	Secured	2.47	±	0.02	<0.001	64.03	±	0.12	<0.001
	Insecured	2.22	±	0.03		60.85	±	0.24	

\* *P*-values were calculated using Student's *t*-test for comparisons between two groups and one-way ANOVA for comparisons among more than two groups. When the overall *P*-value from the ANOVA was <0.05, Bonferroni's post hoc test was applied.

<sup>1)</sup> The DDS is calculated based on the daily consumption of the following food groups: whole grains, vegetables and kimchi, fruits, protein foods (meat, fish, eggs, legumes/tofu), and dairy products.

<sup>2)</sup> The total FL score includes the combined average of the three domains: nutrition and safety, culture and relationship, and social-ecological dimensions.

<sup>3)</sup> KRW: Korean Won.

<sup>4)</sup> Food security status is defined as food secured when both food quantity and quality are sufficient and as food insecure when either or both are insufficient.

**Table 3.** Mean scores of food literacy and dietary diversity score by food security status

Variables	Nutrition and safety FL	Cultural and relational FL	Socio-ecological FL	Total FL <sup>a</sup>	DDS <sup>b</sup>
Secured	65.07 ± 0.14	61.96 ± 0.15	64.28 ± 0.13	63.77 ± 0.11	2.46 ± 0.02
Insecured	64.02 ± 0.24	58.21 ± 0.26	62.66 ± 0.22	61.63 ± 0.20	2.24 ± 0.03
<i>P</i> -value	<0.001	<0.001	<0.001	<0.001	<0.001

\* *P*-values indicate statistical significance at *P* < 0.05.

Adjusted for sex, age, educational attainment, household type, occupation, monthly household income, and subjective health status.

<sup>a</sup> The total FL score includes the combined average of the three domains: nutrition and safety, culture and relationship, and social–ecological dimensions.

<sup>b</sup> The DDS is calculated based on the daily consumption of the following food groups: whole grains, vegetables and kimchi, fruits, protein foods (meat, fish, eggs, legumes/tofu), and dairy products.

**Table 4.** Association between food security status and dietary diversity score stratified by food literacy level

FL Level	Food security <sup>a</sup>	DDS <sup>b</sup>	<i>P</i> -value <sup>*</sup>	<i>P</i> -interaction
High	Secured	2.44 ± 0.03	0.017	<0.001
	Insecured	2.55 ± 0.06		
Moderate	Secured	2.40 ± 0.03	<0.001	
	Insecured	2.21 ± 0.05		
Low	Secured	2.32 ± 0.03	<0.001	
	Insecured	1.74 ± 0.05		

\* *P*-values indicate statistical significance at *P* < 0.05.

Adjusted for sex, age, educational attainment, household type, occupation, monthly household income, and subjective health status.

<sup>a</sup> Food security status is defined as food secured when both food quantity and quality are sufficient and as food insecure when either or both are insufficient.

<sup>b</sup> The DDS is calculated based on the daily consumption of the following food groups: whole grains, vegetables and kimchi, fruits, protein foods (meat, fish, eggs, legumes/tofu), and dairy products.

<sup>c</sup> Food security status is defined as food secured when both food quantity and quality are sufficient and as food insecure when either or both are insufficient.

**Table 5.** Factors affecting high dietary diversity scores, including food security status and food literacy

Variable categories		Model 1		Model 2		Model 3	
		ORs (95% CI)	P-value*	ORs (95% CI)	P-value*	ORs (95% CI)	P-value*
Sex	Male (Ref.)	1.00	-	1.00	-	1.00	-
	Female	1.25 (1.13-1.38)	<0.001	1.26 (1.14-1.39)	<0.001	1.10 (0.99-1.22)	0.072
Age group (years)	18-34 (Ref.)	1.00	-	1.00	-	1.00	-
	35-49	0.86 (0.76-0.99)	0.030	0.86 (0.75-0.98)	0.028	0.83 (0.72-0.95)	0.006
	50-64	1.07 (0.92-1.23)	0.383	1.06 (0.92-1.23)	0.399	1.04 (0.90-1.20)	0.626
Education attainments	High school graduates (Ref.)	1.00	-	1.00	-	1.00	-
	More than college entrance	1.04 (0.92-1.17)	0.525	1.06 (0.94-1.20)	0.321	1.08 (0.95-1.22)	0.245
Household types	Single-person households (Ref.)	1.00	-	1.00	-	1.00	-
	Couple-only households	1.39 (1.17-1.66)	<0.001	1.35 (1.14-1.61)	0.001	1.41 (1.18-1.68)	<0.001
	Households with 2 generations	1.68 (1.42-2.00)	<0.001	1.64 (1.38-1.95)	<0.001	1.70 (1.43-2.02)	<0.001
	Others	0.96 (0.59-1.56)	0.863	0.99 (0.61-1.63)	0.982	1.14 (0.69-1.87)	0.613
Occupations	Professionals (Ref.)	1.00	-	1.00	-	1.00	-
	Service/Sales	1.15 (1.01-1.29)	0.030	1.18 (1.04-1.33)	0.010	1.16 (1.02-1.31)	0.019
	Manual workers	1.11 (0.92-1.34)	0.284	1.14 (0.94-1.38)	0.177	1.21 (1.00-1.47)	0.054
	Students	0.99 (0.76-1.29)	0.932	1.01 (0.78-1.32)	0.917	1.17 (0.89-1.53)	0.253
	Homemakers	0.99 (0.84-1.16)	0.859	0.99 (0.84-1.16)	0.897	0.91 (0.77-1.07)	0.232
	Unemployed/Others	1.45 (0.90-2.34)	0.129	1.62 (1.00-2.62)	0.049	1.64 (1.01-2.66)	0.046
Monthly household income (KRW)	< 2 million (Ref.)	1.00	-	1.00	-	1.00	-
	2-3.5 million	1.36 (0.96-1.93)	0.087	1.34 (0.95-1.91)	0.099	1.38 (0.97-1.97)	0.075
	3.5-5 million	1.40 (0.98-1.99)	0.062	1.36 (0.95-1.93)	0.091	1.36 (0.95-1.94)	0.093
	5-7 million	1.46 (1.02-2.08)	0.036	1.39 (0.98-1.99)	0.068	1.36 (0.95-1.95)	0.092
	≥ 7 million	1.26 (0.88-1.81)	0.212	1.21 (0.84-1.74)	0.304	1.16 (0.81-1.68)	0.417
Subjective health status	Not good (Ref.)	1.00	-	1.00	-	1.00	-
	Moderate	0.99 (0.72-1.36)	0.952	0.92 (0.67-1.27)	0.620	0.87 (0.63-1.21)	0.417
	Good	1.10 (0.81-1.49)	0.546	0.97 (0.71-1.33)	0.863	0.80 (0.59-1.10)	0.174
Food security <sup>b</sup>	Insecured (Ref.)			1.00	-	1.00	-
	Secured			1.36 (1.23-1.52)	<0.001	1.32 (1.18-1.46)	<0.001
Total FL <sup>c</sup>	Q1 (Ref.)					1.00	-
	Q2					1.45 (1.28-1.65)	<0.001
	Q3					1.52 (1.33-1.73)	<0.001
	Q4					2.12 (1.84-2.43)	<0.001
AIC		1,1315.45		1,1284.00		1,1175.83	

\* P-values indicate statistical significance at  $P < 0.05$ .

OR, odds ratio; CI, confidence interval; KRW, Korean Won; FL, food literacy; AIC: Akaike Information Criterion.

Adjusted for sex, age, educational attainment, household type, occupation, monthly household income, and subjective health status.

Odds ratios (ORs) and 95% confidence intervals (CIs) were estimated using logistic regression analysis.

**Model 1:** Adjusted for gender, age, education attainments, household types, occupation, monthly household income, and subjective health status.**Model 2:** Model 1 + added food security.**Model 3:** Model 2 + added total FL.<sup>a</sup> High DDS was defined as a score of  $\geq 3$  on a 5-point scale.<sup>b</sup> Food security status is defined as food secured when both food quantity and quality are sufficient and as food insecure when either or both are insufficient.<sup>c</sup> The total FL score includes the combined average of the three domains: nutrition and safety, culture and relationship, and social-ecological dimensions. The total score was divided into quartiles (Q1-Q4) for analysis.