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Relationship between health literacy, fruit and vegetable consumption, and dietary supplement use among Korean adults

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Objectives: This study examined the relationship between health literacy (HL) and combined patterns of fruit and vegetable (FV) intake as well as dietary supplement (DS) use. **Methods:** This study comprised 5,120 adults who participated in the 2023 Korea National Health and Nutrition Examination Survey. Participants were categorized into four groups based on whether they met FV intake recommendation (≥ 500g/day) and used DS. The groups were as follows: FV&DS (meeting FV intake recommendation and using DS); FV-only (only meeting FV intake recommendation); DS-only (only using DS); and None (neither meeting FV intake recommendation nor using DS). Multinomial logistic regression analyses were performed to examine the association between HL and the four FV-DS groups. **Results:** The proportion of meeting FV intake did not differ significantly according to HL level. The proportion of DS users was highest in the high HL group (72.8%) and lowest in the low HL group (62.5%) (p<0.001). Multinomial logistic regression revealed that individuals with moderate or high HL had significantly higher odds of belonging to the FV&DS or DS-only groups than to the None group. Furthermore, HL was not significantly associated with being in the FV-only group. **Conclusion:** Higher HL was positively associated with a greater likelihood of relying on DS use over FV intake. This suggests a need for deliberate efforts to effectively communicate evidence-based information about FV intake and DS use.

Key words: health literacy, fruit and vegetable intake, dietary supplements

Ⅰ. Introduction

As interest in health promotion continues to rise, the consumption of dietary supplements (DS) has steadily increased in Korea (Korea Health Functional Food Association, 2025). While their widespread use, accumulating evidence suggests that the health benefits of DS are limited. Meta-analyses and systematic reviews have consistently reported that DS use does not provide significant preventive effects against chronic diseases and, in some cases, may even be associated with adverse health outcomes, including increased mortality (Bjelakovic et al., 2012; Myung et al., 2013; US Preventive Services Task Force, 2022). Despite this scientific skepticism, DS continue to be marketed as essential components of healthy diets, and a considerable proportion of adults use DS as part of their health management strategies.

Previous research has identified heterogeneous patterns of DS use. One pattern, often described as the “healthy user” pattern, characterizes individuals who already engage in health-promoting behaviors, such as having healthy diets and regular physical activity, and use DS as a proactive addition to their healthy lifestyles (Dickinson & MacKay, 2014). In contrast, the “compensatory user” pattern refers to individuals who

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rely on DS as a means to address perceived inadequacies in their diet (Yan et al., 2025). These divergent patterns indicate that DS use reflects how individuals interpret, evaluate, and act upon health-related information.

Health literacy (HL), defined as the ability to access, understand, appraise, and use information to inform health-related decisions and actions has widely recognized as a key determinant of health behaviors (Sørensen et al., 2012). While HL is associated with diverse health-promoting behaviors, it is also relevant to dietary decision-making, which requires individuals to navigate complex and often conflicting information regarding nutrient sources, dietary recommendations, and commercial health claims (Forray et al., 2023; Ma et al., 2024). Thus, HL is associated with individual dietary choices, including what to eat, how much to eat, and what combinations to eat.

One of the important component of healthy diets is adequate consumption of fruits and vegetables (FV). FV are rich sources of vitamins, minerals, fiber, and phytochemicals, and high intake has been consistently linked to reduced risks of chronic diseases such as obesity, hypertension, cancer, and mortality (Aune et al., 2017). Accordingly, dietary guidelines recommend consuming at least 400–500g of FV per day, preferably in whole food form to prevent non-communicable diseases and micronutrient deficiencies (Ministry of Health and Welfare & The Korean Nutrition Society, 2020; World Health Organization, 2003). Due to the high consumption of salted vegetables, such as kimchi, the dietary guidelines for Koreans recommend a daily FV intake of 500g or more, which is higher than international recommendations (Ministry of Health and Welfare & The Korean Nutrition Society, 2020). In contrast to this whole FV consumption recommendation, reliance on DS as a means of meeting nutritional needs has increased (Korea Health Functional Food Association, 2025). While DS may be beneficial for specific populations, such as folic acid supplementation for pregnant women, whole foods are recognized as superior due to their synergistic matrix of micronutrients and phytochemicals that DS cannot replicate (Liu, 2003). Thus, public health guidelines consistently emphasize a food-first approach, recommending that DS should not be prioritized over whole foods (US Department of Agriculture & US Department of Health and Human Services, 2020). This distinction underscores the importance of understanding whether individuals prioritize whole-food sources, such as FV, or rely on DS as an alternative strategy for nutrient intake.

Existing evidence suggests that higher HL is associated with better diet quality and higher FV consumption (Forray et al., 2023; Ma et al., 2024). From this perspective, individuals with higher HL may be expected to recognize the limited benefits of DS and to prioritize nutrient intake from whole-food sources such as FV. However, it is also possible that higher HL does not necessarily lead to healthier dietary choices, such as adopting a food-first approach. Recent studies have highlighted that, as the nutrition and health information environment becomes increasingly complex and commercially driven, the ability to merely access and understand nutrition information may be insufficient. Instead, greater emphasis has been placed on critical nutrition literacy, defined as the capacity to critically evaluate nutrition-related information and claims (Bedoyan et al., 2021; Guttersrud et al., 2014). In particular, DS market is characterized by aggressive marketing strategies that strongly emphasize health benefits. In this context, individuals are required to possess the ability to critically evaluate such claims in light of established dietary guidelines and scientific evidence.

To our knowledge, the relationship between HL, DS use, and FV intake has not been fully understood. Notably, a meta-analysis reported that higher HL is

associated with increased DS use (Intarakamhang & Prasittichok, 2022), whereas another study showed that among DS non-users, greater knowledge about DS was associated with lower trust in DS advertisements (Karbownik et al., 2019). This discrepancy suggests that higher HL does not necessarily translate into critical skepticism toward DS use in practice, highlighting the need for further investigation.

Therefore, the purpose of this study was to investigate the association between HL and combined patterns of FV intake and DS use among Korean adults. Using nationally representative data, this study classified individuals into four distinct groups based on whether they met the FV intake recommendation and whether they used DS. By examining how HL relates to these combined dietary patterns, this study aims to provide deeper insight into the role of HL in shaping real-world nutritional strategies and to inform future nutrition education and public health interventions.

Ⅱ. Methods

1. Study design

This study employed a cross-sectional design using secondary data.

2. Data and participants

This study used data from the 2023 Korea National Health and Nutrition Examination Survey (KNHANES), a nationally representative survey of Korean residents. The Korea Disease Control and Prevention Agency conducts this survey annually to examine health status, health behaviors, and food and nutrient intake in the Korean population. Detailed information on the survey design and methodology was described elsewhere (Kweon et al., 2014).

The participants of this study were adults aged 19 years or older who completed HL questionnaire and 24-hour dietary recall, and reported DS use. In the 2023 KNHANES, 6,929 individuals participated. After excluding individuals younger than 19 years (n=1,022), those who did not participate in the 24-hour dietary recall (n=126), those with implausible energy intake (< 500kcal/day or > 5000kcal/day; n=84), those who did not complete the HL questionnaire (n=1), pregnant women (n=20), and those missing information on any study variables (n=556), a total of 5,120 participants were included in the analysis.

3. Variables

1) Health literacy

HL was assessed using the Health Literacy Index for the Community (HLIC), a 10-item scale measuring four domains: disease prevention (3 items), health promotion (1 item), healthcare (4 items), and technology and resources (2 items). Each item was rated on a 4-point Likert scale from never (1) to always (4). Responses of "Don't know" or no responses were scored as 1, in accordance with the guideline (Cho et al., 2022). Total scores ranged from 10 to 40. Based on the categorization suggested in the HLIC development study, scores of 10-28 were classified as low, 29-31 as moderate, and 32-40 as high HL (Cho et al., 2022).

2) Fruit and vegetable intake

FV intake was calculated using data from the 24-hour dietary recall. Trained dietitians asked participants to report all foods and beverages consumed during the day prior to the survey. Foods classified as vegetables, mushrooms, seaweeds, or fruits were included in FV intake. Participants were categorized into two groups based on whether they met the FV intake recommendation (≥ 500g/day) set by the Dietary Guidelines for Koreans (Ministry of Health and Welfare & The Korean Nutrition Society, 2020).

3) Dietary supplement use

Participants who reported having taken DS for more than two weeks in the past year were classified as DS users, and all others were classified as non-users.

4) Covariates

Recent studies using nationally representative data from the KNHANES and the Korea Health Panel Survey have reported that HL levels among Korean adults vary by sex, age, income, educational attainment, and healthy lifestyle factors, such as smoking status and physical activity (Bae & Kim, 2023; Choi et al., 2025). Socioeconomic status is also closely related to DS use and diet quality, including FV consumption (Choi, 2022; Park et al., 2025). Furthermore, health behaviors tend to cluster; for instance, individuals who have healthy diets are more likely to adopt additional healthy behaviors, such as non-smoking and regular physical activity (Dickinson & MacKay, 2014). Consequently, sociodemographic characteristics, health behaviors, and health status—all of which are known to be associated with HL, FV intake, or DS use—were included as covariates in the analysis.

Sociodemographic characteristics included sex, age, educational attainment, and household income (quartiles). Health behavior variables included alcohol drinking, cigarette product use, and physical activity. Participants who reported drinking alcohol in the past year were classified as drinker. Tobacco product use was determined based on current use of any tobacco product, including combustible cigarettes, electronic cigarettes, chewing tobacco, hookah, cigars, etc. Physical activity was defined as engaging in at least 150 minutes per week of moderate-intensity activity. Health status variables included body weight, subjective health status, and chronic disease diagnosis. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2) and categorized as underweight ($< 18.5 kg/m^2$), normal weight ($18.5-22.9 kg/m^2$), overweight ($23.0-24.9 kg/m^2$), and obesity ($\geq 25.0 kg/m^2$). Subjective health status was assessed using a 5-point Likert scale ranging from very bad to very good and categorized as good, fair, and bad. Participants were considered to have a chronic disease if their health examination results met diagnostic criteria for diabetes, hypertension, or hypercholesterolemia; were taking medication for these diseases; reported being diagnosed with diabetes or hypertension; or were using insulin for blood sugar control.

4. Statistical analysis

Rao-Scott chi-square tests were used to compare the distribution of sociodemographic, health behavior, and health status variables according to HL level. Participants were categorized into four FV-DS groups: (1) meeting the FV intake recommendation (FV intake $\geq$ 500g/d) and using DS (FV&DS); (2) meeting the FV intake recommendation and not using DS (FV-only); (3) not meeting the FV intake recommendation and using DS (DS-only); and (4) not meeting the FV intake recommendation and not using DS (None). Group membership according to HL level, as well as participants' characteristics by FV-DS group, was compared using Rao-Scott chi-square tests. We analyzed the association between HL and FV-DS group membership using weighted multinomial logistic regression models. In the crude model, covariates were not adjusted. In the adjusted model, sex, age, educational attainment, household income, alcohol drinking, smoking, physical activity, body weight, subjective health status, and chronic disease were adjusted. All statistical analyses were conducted using SAS 9.4 (SAS Institute Inc., Cary, NC). To account for the complex sampling design of KNHANES, SAS survey procedures were used in all analyses with sampling weights, primary sampling units, and stratification. Statistical significance was set at $p<.05$.

Ⅲ. Results

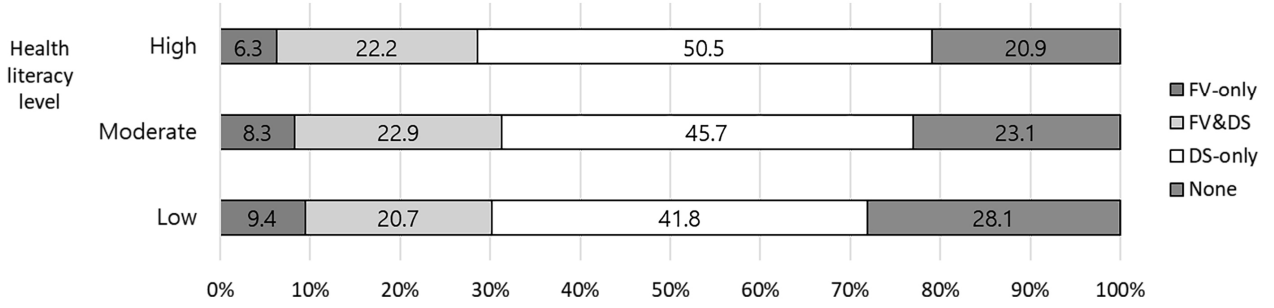
1. Characteristics of study participants by health literacy level

Among all study participants, 25.3% had low HL, 36.9% had moderate HL, and 26.7% had high HL (data not shown). HL levels differed significantly across all covariates included in this study. Individuals who were women, aged 19-39 years, had higher educational attainment, had higher income, engaged in healthier lifestyles such as no alcohol drinking, non-smoking, and participation in more than 150 minutes/week of physical activity, had normal weight, reported better subjective health, and did not have a chronic disease were more likely to have higher HL compared with their counterparts (p<.01) 〈Table 1〉.

〈Table 1〉 Characteristics of study participants by health literacy level

Unit: N (weighted %)

Variable	Category	Total N	Health literacy level			
			Low	Moderate	High	p-value
Sex	Men	2,235	739 (31.2)	943 (41.5)	553 (27.3)	<.001
	Women	2,885	824 (25.7)	1192 (41.5)	869 (32.8)	
Age (years)	19-39	1,154	249 (22.0)	421 (36.5)	484 (41.5)	<.001
	40-64	2,472	626 (25.3)	1103 (44.7)	743 (30.0)	
	65+	1,494	688 (45.3)	611 (42.2)	195 (12.4)	
Educational attainment	Middle school graduate or less	1,288	687 (52.5)	468 (37.5)	133 (9.9)	<.001
	High school graduate	1,722	487 (28.4)	788 (44.5)	447 (27.1)	
	College graduate or higher	2,110	389 (18.8)	879 (40.9)	842 (40.3)	
Household income	Q1	924	457 (46.6)	328 (35.6)	139 (17.9)	<.001
	Q2	1,232	407 (31.2)	529 (42.7)	296 (26.0)	
	Q3	1,425	364 (24.5)	633 (43.8)	428 (31.7)	
	Q4	1,539	335 (22.3)	645 (41.2)	559 (36.5)	
Alcohol drinking	Yes	915	560 (30.1)	593 (24.0)	341 (19.8)	<.001
	No	4,205	1003 (69.9)	1542 (76.0)	1081 (80.2)	
Cigarette product use	Yes	1,494	324 (33.9)	375 (40.6)	216 (25.5)	<.001
	No	3,626	1239 (26.9)	1760 (41.8)	1206 (31.3)	
Physical activity	Yes	2,364	598 (23.9)	997 (41.6)	769 (34.5)	<.001
	No	2,756	965 (32.8)	1138 (41.5)	653 (25.7)	
Body weight	Underweight	233	64 (25.4)	106 (47.2)	63 (27.4)	.003
	Normal weight	1,912	515 (25.1)	830 (42.8)	567 (32.1)	
	Overweight	1,161	370 (29.4)	477 (41.6)	314 (29.0)	
	Obesity	1,814	614 (31.6)	722 (39.4)	478 (28.9)	
Subjective health status	Good	1,689	391 (20.6)	659 (39.8)	639 (39.6)	<.001
	Normal	2,474	789 (30.7)	1100 (43.9)	585 (25.5)	
	Bad	957	383 (38.1)	376 (38.6)	198 (23.3)	
Chronic disease	Yes	2,505	911 (34.5)	1069 (43.5)	525 (22.0)	<.001
	No	2,615	652 (24.0)	1066 (40.1)	897 (35.9)	



[Figure 1] Fruit and vegetable intake and dietary supplement use by health literacy level

Notes. FV=fruits and vegetables; DS=dietary supplement; FV-only=Meeting FV intake recommendation(≥500g/day) and not using DS; DS-only=using DS and not meeting FV intake recommendation; FV&DS=Meeting FV intake recommendation and using DS; None=Not meeting FV intake recommendation and not using DS.
Proportion of FV-DS group membership by health literacy level was significantly different (p<.001).

〈Table 2〉 Association between fruit and vegetable intake, dietary supplement use, and health literacy

Unit: Odds ratio (95% confidence interval)

		FV&DS versus None		FV-only versus None		DS-only versus None	
Variable	Category	Crude	Adjusted[1)]	Crude	Adjusted[1)]	Crude	Adjusted[1)]
Health literacy	Low	ref	ref	ref	ref	ref	ref
	Moderate	1.35 (1.10-1.66)	1.30 (1.05-1.62)	1.07 (0.83-1.38)	1.10 (0.84-1.44)	1.33 (1.13-1.57)	1.24 (1.04-1.47)
	High	1.44 (1.15-1.81)	1.78 (1.37-2.31)	0.90 (0.66-1.21)	1.21 (0.88-1.66)	1.54 (1.23-1.91)	1.51 (1.22-1.88)

Notes. FV=fruits and vegetables; DS=dietary supplement; FV-only=Meeting FV intake recommendation (≥500g/day) and not using DS; DS-only=using DS and not meeting FV intake recommendation; FV&DS=Meeting FV intake recommendation and using DS; None=Not meeting FV intake recommendation and not using DS.
[1)] Adjusted for sex, age, educational attainment, household income, alcohol drinking, tobacco product use, physical activity, body weight, subjective health status, and chronic disease.

2. Fruit and vegetable intake and dietary supplement use by health literacy level

[Figure 1] presents FV-DS group membership, classifying participants by combined FV intake and DS use, according to HL levels. The proportion of individuals meeting FV intake recommendation did not differ significantly by HL level (28.5% for those with high HL, 31.2% for those with moderate HL, and 30.1% for those with low HL). The proportion of DS users was the highest among individuals with high HL (72.8%), followed by individuals with moderate HL (68.6%), and individuals with low HL (62.5%) (p<.001). FV–DS group membership differed significantly by HL level (p<.001). Individuals with low HL had the highest proportion in FV-only (9.4%) and None (28.1%) groups; while individuals with high HL had the lowest proportions of those in FV-only (6.3%) and None (20.9%) groups, and the highest proportion of in the DS-only (50.5%) group.

3. Association between fruit and vegetable intake, dietary supplement, and health literacy level

As shown in 〈Table 2〉, individuals with moderate or high HL had significantly higher odds of belonging to the FV&DS or DS-only groups rather than the None group compared with those with low HL, in both crude and adjusted models. However, HL level was not associated with the likelihood of being in the FV-only group relative to the None group.

Ⅳ. Discussion

This study examined the association between HL, FV intake, and DS use among Korean adults. By categorizing participants into four combined FV–DS groups, this study provided a nuanced understanding of how HL relates not only to individual health behaviors, but also to distinct dietary strategies for meeting nutritional needs. The findings demonstrated that higher HL was associated with greater DS use, whereas HL was not associated with meeting FV intake recommendations without DS use. Our findings revealed a complex relationship in which individuals with higher HL were more likely to report DS use, but not necessarily greater adherence to a food-first dietary approach.

Individuals with moderate or high HL had significantly higher odds of belonging to the FV&DS or DS-only groups compared with the None group. These findings may reflect health consciousness of people with higher HL. Previous studies reported that individuals with higher HL are more proactive about their health status and often engage in a cluster of healthy behaviors (Buja et al., 2020; Choi et al., 2025). Individuals with higher HL in this study were also more likely to engage in other health-promoting behaviors, supporting the interpretation that HL reflects a general tendency toward proactive health management. They may choose DS use as one of strategies to manage their health. Previous research in Korea also has similarly reported a positive association between the purchase of healthy whole foods and DS (Kang et al., 2017), indicating that DS use may be perceived as a component of a healthy lifestyle, rather than just a remedy for nutrient deficiency.

A noteworthy finding of this study was that individuals with high HL had a significantly higher likelihood of using DS without meeting the FV intake recommendation. Specifically, compared with individuals with low HL, they had 1.51 times higher odds of belonging to the DS-only group rather than the None group. This result suggests that higher HL does not necessarily translate into prioritizing nutrient intake from whole foods, which is a fundamental principle emphasized in dietary guidelines (World Health Organization, 2003). Although individuals with higher HL are generally expected to make more evidence-based health decisions, the present findings indicate that they may still adopt DS use as an alternative strategy for meeting perceived nutritional needs rather than increasing FV consumption. Several factors may explain this pattern. Meeting FV intake recommendations requires not only nutritional knowledge, but also economic resources to purchase fresh produce and sustained behavioral effort, including meal planning, food preparation, and healthy food choices in out-of-home food environments (Pinho et al., 2018). These requirements impose substantial time and cognitive costs, which may not be sufficiently addressed by higher levels of HL alone. In addition, high prices for fresh produce in Korea have been identified as a significant barrier to adequate FV intake (Hwang, 2024). As a result, even individuals with high HL may perceive DS use a low-effort and highly accessible strategy and favor DS over exclusive reliance on FV to meet their nutritional needs (Hoseini et al., 2021).

From a public health perspective, this finding highlights a potential mismatch between general HL and evidence-based dietary practices. The elevated odds of DS-only use among individuals with high HL suggest that general HL alone may be insufficient to promote a food-first dietary approach. It may reflect limited critical nutrition literacy, which enables individuals to critically evaluate DS marketing in light of established dietary guidelines (Velardo, 2015). While critical nutrition literacy was not directly measured in this study, our findings suggest that higher HL does not

necessarily guarantee such specialized competency. In particular, higher HL may increase exposure to DS-related information through healthcare settings, digital media, and commercial marketing, without necessarily enhancing critical appraisal of their health claims. In this sense, DS-only behavior does not reflect a lack of health knowledge, but rather a pattern of health engagement in the absence of strong critical nutrition literacy. Nutrition education strategies should therefore place greater emphasis on fostering HL as well as critical nutrition literacy, enabling individuals to critically evaluate DS marketing claims and to understand the comparative benefits of whole foods versus DS. For example, public health interventions could incorporate educational programs that train individuals to critically assess DS advertisements and online nutrition information, interpret nutrition labels and health claims, and apply dietary guidelines to real-world food choices through practical learning activities such as supermarket tours or food label reading workshops.

Individuals with low HL were significantly more likely to belong to the "None" group—meeting neither the FV intake recommendation nor using DS. This pattern may reflect a general lack of engagement in nutritional health and dietary behaviors. Given that HL is a key determinant of health (Sørensen et al., 2012), this group should be prioritized as a primary target for public health interventions. Individuals in this group are likely to face multiple barriers, including limited access to health information, lower socioeconomic status, and poorer health status (Choi et al., 2025). In addition, limited HL may restrict individuals' ability to recognize nutritional inadequacies and to seek appropriate dietary guidance, further reinforcing disengagement from healthy eating practices. Addressing these compounded barriers requires interventions that combine basic nutrition education with improved access to affordable and healthy food options. Targeted strategies are therefore needed to improve their access to, and understanding of, nutritional information and dietary requirements.

This study had several limitations that should be considered when interpreting the results. First, given its cross-sectional design, we could not establish a causal relationship between HL, FV intake, and DS use. For example, while higher HL may influence dietary strategies, it is also plausible that DS users have greater exposure to health-related information and commercial marketing, which in turn could result in higher HL scores. Second, the KNHANES data lacked information on the specific types of DS consumed and the exact dosages of nutrients obtained from them. According to the Korea Health Functional Food Association (2025), however, red ginseng and vitamins account for the largest share of the DS market. We can therefore infer that a significant portion of participants may have used DS to supplement micronutrients found in FV. Third, FV intake was estimated based on a single 24-hour dietary recall, thus it may not reflect an individual's usual FV intake. Furthermore, DS use was defined as the consumption of supplements for more than two weeks during the past year. This discrepancy in assessment periods between FV intake and DS use poses a significant challenge to the internal validity of the group classification. Specifically, this potential mismatch may lead to misclassification bias. For example, individuals who consumed less FV on the recall day than their usual intake might have been erroneously classified into the 'DS-only' or 'None' groups. Such inconsistencies in measurement scales may lead to an over- or under- estimation of the observed associations. Finally, we used general HL rather than nutrition- or food-specific literacy. As the HLIC, HL measurement of KNHANES, does not include diet-specific items, the HL levels reported may not fully capture participants' specific capacity related to

dietary practices. However, we performed a sensitivity analysis using "nutrition label use" as a proxy for nutritional literacy and observed consistent results. Nutrition label use was associated with significantly increased odds of belonging to the FV&DS (OR: 1.65) or DS-only groups (OR: 1.71), using the None group as the reference (data not shown). This suggests that the potential bias arising from the use of a general HL measurement tool is likely limited.

Ⅴ. Conclusion

This study found that individuals with higher HL were more likely to report DS use without meeting the FV intake recommendation, suggesting that higher HL does not necessarily guarantee adherence to a food-first dietary approach. Therefore, increasing individual HL levels is not the sole solution for promoting healthy dietary behaviors such as FV consumption. To promote healthy diets, future nutrition education and communication strategies should be designed to empower individuals to effectively apply their HL competencies. Specifically, these strategies need to clarify that healthy diets are not just about the quantitative fulfillment of nutrients. Instead, emphasis must be placed on the superior, long-term health benefits of obtaining nutrients through diverse whole foods, such as FV, rather than DS. In addition, interventions aimed at strengthening critical nutrition literacy—particularly the ability to critically evaluate commercial food and DS information—are needed to support more evidence-based dietary decision-making. Alongside individual-level strategies, environmental and policy-level efforts that makes FV intake the easier choice for everyone. Comprehensive approach is required, including pricing policies to ensure affordability of FV, enhancing the accessibility of FV as snack options, and providing FV in ready-to-eat forms. These multi-faceted efforts would be beneficial to enable healthy eating for all individuals, regardless of their HL level.

References

Aune, D., Giovannucci, E., Boffetta, P., Fadnes, L. T., Keum, N., Norat, T., Greenwood, D. C., Riboli, E., Vatten, L. J., & Tonstad, S. (2017). Fruit and vegetable intake and the risk of cardiovascular disease, total cancer and all-cause mortality—A systematic review and dose-response meta-analysis of prospective studies. *International Journal of Epidemiology, 46*(3), 1029–1056. https://doi.org/10.1093/ije/dyw319

Bae, J., & Kim, H. (2023). Health literacy in Korea: Findings from a nationally representative survey. *Health & Social Welfare Review, 316*, 81-94. https://doi.org/10.23062/2023.02.7

Bedoyan, J., McNamara, J., Olfert, M. D., Byrd-Bredbenner, C., & Greene, G. W. (2021). Establishing criterion validity for the Revised critical nutrition literacy tool in U.S. college students. *Journal of Education and Health Promotion, 10*(1), Article 37. https://doi.org/10.4103/jehp.jehp_632_20

Bjelakovic, G., Nikolova, D., Gluud, L. L., Simonetti, R. G., & Gluud, C. (2012). Antioxidant supplements for prevention of mortality in healthy participants and patients with various diseases. *Cochrane Database of Systematic Reviews, 3*, Article CD007176. https://doi.org/10.1002/14651858.CD007176.pub2

Buja, A., Rabensteiner, A., Sperotto, M., Grotto, G., Bertoncello, C., Cocchio, S., Baldovin, T., Contu, P., Lorini, C., & Baldo, V. (2020). Health literacy and physical activity: A systematic review. *Journal of Physical Activity and Health, 17*(12), 1259-1274. https://doi.org/10.1123/jpah.2020-0161

Cho, J., Kang, S. J., Yoon, J. (2022). *Development of health literacy index for the Korea National Health and Nutrition Examination Survey*. Korea Disease Control and Prevention Agency.

Choi, J. (2022). A study on the dietary behavior of Korean adults: focus on dietary supplement intake, household size, and COVID-19. *Korean Journal of Community Nutrition, 27*(6), 468-479. https://doi.org/10.5720/kjcn.2022.27.6.468

Choi, S., Kang, Y., Kim, H., & Oh, K. (2025). Health literacy in Korea: Findings from the 2023 Korea National Health and Nutrition Examination Survey. *Epidemiology and*

Health, 47, Article e2025037. https://doi.org/10.4178/epih.e2025037

Dickinson, A., & MacKay, D. (2014). Health habits and other characteristics of dietary supplement users: A review. *Nutrition Journal, 13*, Article 14. https://doi.org/10.1186/1475-2891-13-14

Forray, A. I., Coman, M. A., Chereches, R. M., & Borzan, C. M. (2023). Exploring the impact of sociodemographic characteristics and health literacy on adherence to dietary recommendations and food literacy. *Nutrients, 15*(13), Article 2853. https://doi.org/10.3390/nu15132853

Guttersrud, Ø., Dalane, J. Ø., & Pettersen, S. (2014). Improving measurement in nutrition literacy research using Rasch modelling: Examining construct validity of stage-specific 'critical nutrition literacy' scales. *Public Health Nutrition, 17*(4), 877-883. https://doi.org/10.1017/S1368980013000530

Hoseini, A., Dehdari, T., Solhi, M., Rahideh, S. T., & Janani, L. (2021). Qualitative exploration of the factors influencing the use of dietary supplements in Iranian women: Introduction to areas of focus for developing interventions. *Heliyon, 7*(4), Article e06672. https://doi.org/10.1016/j.heliyon.2021.e06672

Hwang, J.-Y. (2024). *Facilitators and barriers to fruit and vegetable intake* [Oral presentation]. 2024 Korean Society of Food Science and Nutrition International Symposium and Annual Meeting, Jeju Island, Korea.

Intarakamhang, U., & Prasittichok, P. (2022). Health literacy in dietary supplement use among working-age groups: Systematic review and meta-analysis. *Heliyon, 8*(8), Article e10320. https://doi.org/10.1016/j.heliyon.2022.e10320

Kang, H.-G., Joo, H. H., Choi, K. D., Lee, D., & Moon, J. (2017). Complementarity in dietary supplements and foods: Are supplement users vegetable eaters? *Food & Nutrition Research. 61*, Article 1361769. https://doi.org/10.1080/16546628.2017.1361769

Karbownik, M. S., Paul, E., Nowicka, M., Nowicka, Z., Kowalczyk, R. P., Kowalczyk, E., & Pietras, T. (2019). Knowledge about dietary supplements and trust in advertising them: Development and validation of the questionnaires and preliminary results of the association between the constructs. *PLoS ONE, 14*(6), Article e0218398. https://doi.org/10.1371/journal.pone.0218398

Korea Health Functional Food Association. (2025, November 20). *The health functional food market is projected to reach 5.9626 trillion won by 2025. It has become a part of daily routines for Koreams under the 'K-Health W.A.V.E.'*. https://www.khff.or.kr/user/info/InfoBoardUserView.do?searchBoardSeqno=0&searchCategoryCd=&infoType=&applyNo=&emailTitle=&boardSeqno=10035&postsGrpId=SS001&postsSeqno=120107&searchCondition=title&searchKeyword=&pageIndex=1&searchSortNms=null&searchSortOrders=null&_menuNo=369

Kweon, S., Kim, Y., Jang, M., Kim, Y., Kim, K., Choi, S., Chun, C., Khang, Y.-H., & Oh, K. (2014). Data resource profile: The Korea national health and nutrition examination survey (KNHANES). *International Journal of Epidemiology, 43*(1), 69-77. https://doi.org/10.1093/ije/dyt228

Liu, R. H. (2003). Health benefits of fruit and vegetables are from additive and synergistic combinations of phytochemicals. *The American Journal of Clinical Nutrition, 78*(3), 517S-520S. https://doi.org/10.1093/ajcn/78.3.517S

Ma, C., Ren, Z., Chen, Z., & Li, C. (2024). The association between interactive health literacy and dietary behaviors among Chinese college students: A large-scale cross-sectional study. *Frontiers in Psychology, 15*, Article 1363885. https://doi.org/10.3389/fpsyg.2024.1363885

Ministry of Health and Welfare & The Korean Nutrition Society. (2021). *Application on of 2020 dietary reference intakes for Koreans*. Ministry of Health and Welfare.

Myung, S.-K., Ju, W., Cho, B., Oh, S.-W., Park, S. M., Koo, B.-K., & Park, B.-J. (2013). Efficacy of vitamin and antioxidant supplements in prevention of cardiovascular disease: Systematic review and meta-analysis of randomised controlled trials. *BMJ, 346*, Article f10. https://doi.org/10.1136/bmj.f10

Park, D., Shin, M.-J., Subramanian, S. V., Park, C. Y., & Kim, R. (2025). Individual- and neighborhood-level factors influencing diet quality: A multilevel analysis using Korea National Health and Nutrition Examination Survey data, 2010-2019. *Epidemiology and Health, 47*, Article e2025043. https://doi.org/10.4178/epih.e2025043

Pinho, M. G. M., Mackenbach, J. D., Charreire, H., Oppert, J.-M., Bárdos, H., Glonti, K., Rutter, H., Compernolle, S., De Bourdeaudhuij, I., Beulens, J. W. J., Brug, J., & Lakerveld, J. (2018). Exploring the relationship between perceived barriers to healthy eating and dietary behaviours in European adults. *European Journal of Nutrition, 57*(5), 1761-1770. https://doi.org/10.1007/s00394-017-1458-3

Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., Brand, H., & (HLS-EU) Consortium Health Literacy Project European. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health, 12*, Article 80. https://doi.org/10.1186/1471-2458-12-80

US Department of Agriculture & US Department of Health and Human Services. (2020). *Dietary guidelines for Americans, 2020-2025* (9th ed.). US Government Publishing Office.

US Preventive Services Task Force. (2022). Vitamin, mineral,

and multivitamin supplementation to prevent cardiovascular disease and cancer: US Preventive Services Task Force recommendation statement. *JAMA, 327*(23), 2326-2333. https://doi.org/10.1001/jama.2022.8970

Velardo, S. (2015). The nuances of health literacy, nutrition literacy, and food literacy. *Journal of Nutrition Education and Behavior, 47*(4), 385-389. https://doi.org/10.1016/j.jneb.2015.04.328

World Health Organization. (2003). *Diet, nutrition and the prevention of chronic diseases: Report of a joint WHO/FAO expert consultation*.

Yan, X., Zhao, M., Chen, S., Zhang, J., Liu, W., & Wu, T. (2025). Dietary supplement consumption is associated with lower dietary quality in Chinese university students based on a cross-sectional study. *Scientific Reports, 15*, Article 29180. https://doi.org/10.1038/s41598-025-11947-2

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