

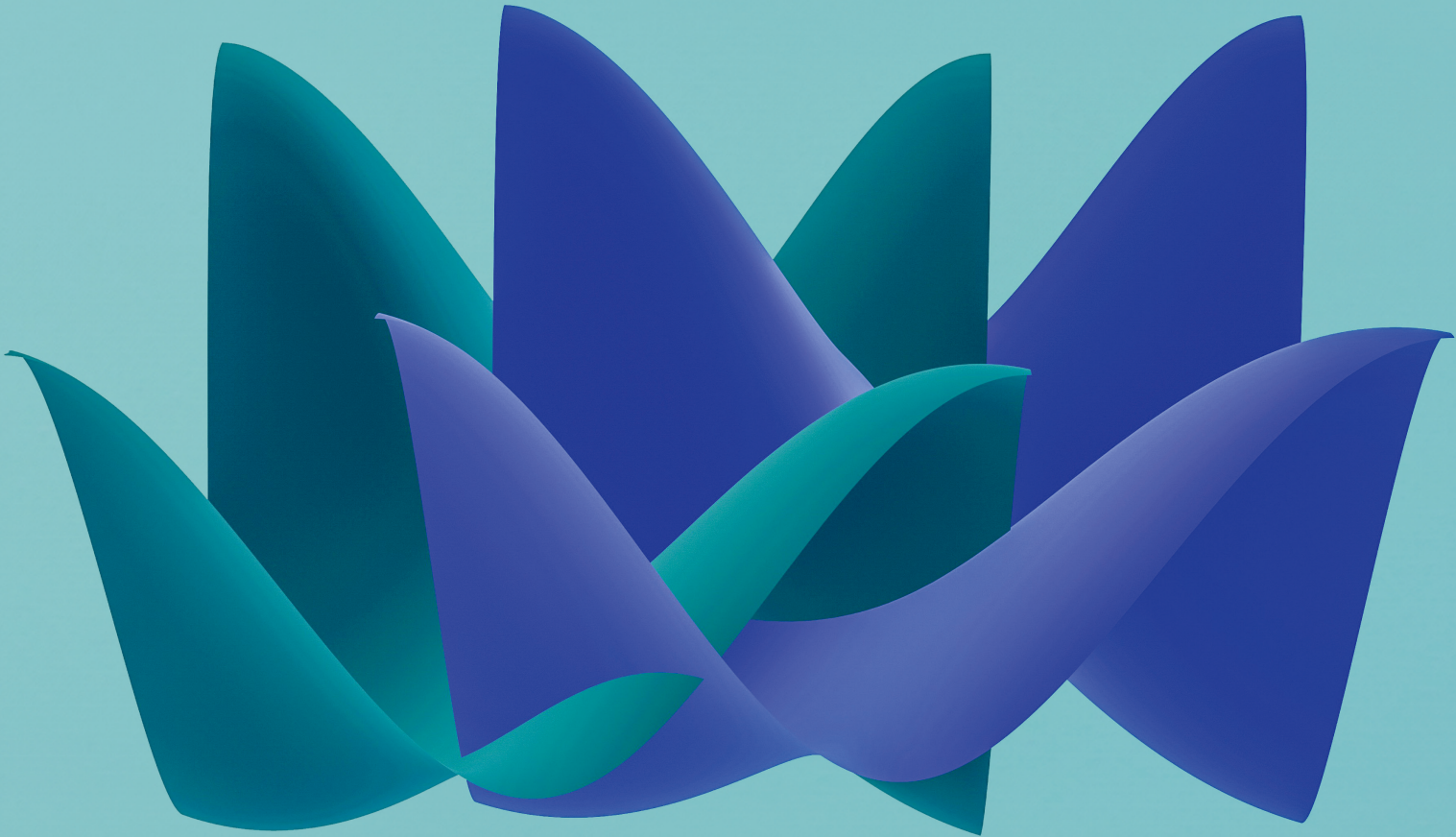


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The Korean Society of Community Nutrition

AIMS AND SCOPE

The *Korean Journal of Community Nutrition* is the official peer-reviewed journal of the Korean Society of Community Nutrition. It was launched in 1996. The previous primary titles were Jiyeog sahoe yeong-yang hag-hoeji (pISSN 1226-0983) from vol. 1, no. 1 to vol 3, no. 5, and Daehan Jiyeok sahoe yeong-yang hakoeji (pISSN 1226-0983, eISSN 2287-1624) from vol. 4, no. 1 to vol. 27 no. 4. The English title (parallel title) was Korean Journal of Community Nutrition from vol. 4, no. 1 to vol. 27 no. 4. The *Korean Journal of Community Nutrition* has been the current primary title since October, 2022 (eISSN 2951-3146). The abbreviated title of the journal is *Korean J Community Nutr.* It is published bimonthly in February, April, June, August, October and December. It began to be published only as an e-journal from 2022.

BACKGROUND

KJCN was first published in March, 1996. Three issues were published in 1996, and then five issues per year was published from 1997 to 2001. Since 2002, KJCN has become a bimonthly journal. It is published in February, April, June, August, October and December. This work was supported by the Korean Federation of Science and Technology Societies(KOFST) grant funded by the Korean government. The abbreviated title of the journal is ‘Korean J Community Nutr’.

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ABSTRACTING AND INDEXING

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Review

Life-course nutrition strategies for Korean middle-aged adults across biological transitions, nutritional burdens, and a community-linked precision nutrition model: a narrative review

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Objectives: To describe the nutritional challenges faced by Korean middle-aged adults (40–64 years) from a life-course and biological transition perspective and to propose systems-based precision nutrition strategies for this critical stage of the lifespan.

Methods: In this narrative review, PubMed, Medline, and Web of Science were searched for articles published between January 2010 and November 2025 using terms such as “middle aged nutrition,” “healthy aging,” “life course nutrition,” “sarcopenia,” “precision nutrition,” and “chronic diseases.” Policy documents and major national cohort and intervention studies were also reviewed.

Results: Middle-aged adults in Korea have a high prevalence of chronic disease beginning in their 40s, showing “the triple burden of malnutrition:” obesity, insufficient micronutrients, and sarcopenia onset, along with excessive sodium and sugar consumption combined with socioeconomic factors like living alone. Nutrient and dietary approaches, such as high protein (1.2–1.5 g/kg/d), leucine, dairy products and fruits, anti-inflammatory foods intake, Dietary Approaches to Stop Hypertension (DASH) or Mediterranean diets plus lifestyle modification at public health centers (Korean Diabetes Prevention Study) for cardiometabolic risks, Mediterranean-DASH Intervention for Neurodegenerative Delay diet for cognition maintenance, could greatly impact health trajectories.

Conclusion: Korean middle-aged adults experience a triple burden of malnutrition on top of nonlinear biological aging shifts, which together accelerate cardiometabolic, musculoskeletal, and cognitive risks. Implementing targeted dietary strategies within a systems-based, community-linked precision nutrition model is essential to reshape health trajectories and promote healthy longevity in this population.

Keywords: middle aged; healthy aging; sarcopenia

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INTRODUCTION

Modern society is facing unprecedented demographic shifts and rapid aging, which fundamentally reshapes public health and nutritional priorities. With increasing life expectancy, narrowing the gap between “life expectancy” and

“healthy life expectancy” (without disease or disability) has become a health imperative. The World Health Organization defines “healthy aging” not simply as the absence of disease but developing and maintaining the functional ability that enables well-being in older age [1]. Similarly, the National Academy of Medicine defines healthy longevity as a state with maintained physical, cognitive, and social functioning, and a time lived in good health approaching the biological life span [2]. Within this paradigm, middle adulthood (aged 40–64 years) is considered the most critical life transition that determines a lifelong health trajectory [3].

According to previous reviews targeting children and adolescents, early life stages are a plasticity window where dietary behaviors are formed and fixed; nutritional imbalances during this period can lead to intergenerational health inequalities [4]. However, recent life-course epidemiology and multi-omics studies suggest that middle adulthood is not just progressive aging but a “a potentially critical window of plasticity” where existing health trajectories can be actively reshaped [5, 6].

Traditional aging biology assumed that over time cellular function and metabolic efficiency decrease gradually and linearly. However, recent studies using advanced multi-omics profiling have revealed that human aging does not occur at a constant rate but follows a nonlinear trajectory accompanied by explosive molecular biological fluctuations at specific ages [7]. During middle adulthood, the basal metabolic rate decreases, drastic endocrine changes such as menopause occur, and musculoskeletal degeneration begins. Simultaneously, continuous exposure to the modern obesogenic environment can result in a triple burden of malnutrition, where obesity due to energy overconsumption, micronutrient deficiencies, and age-related sarcopenia appear concurrently during this life stage [8]. According to epidemiological modeling studies, modifiable lifestyle factors such as diet, physical activity, and weight management have the strongest impact on healthspan extension.

Therefore, this narrative review aims to analyze the key nutritional challenges faced by Korean middle-aged adults by synthesizing recent epidemiological data, biological multi-omics research, and behavioral science frameworks. It examines disease-specific dietary strate-

gies, such as the Mediterranean diet, Dietary Approaches to Stop Hypertension (DASH) diet, and Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet, as well as the results of large-scale clinical interventions, such as the Korean Diabetes Prevention Study (KDPS). Accordingly, it proposes a “systems-centered, community-linked precision nutrition model” to successfully improve health outcomes during this life transition.

METHODS

Ethics statement

As this study is a narrative review, it did not require institutional review board approval or individual consent.

Study design

This narrative review draws together current evidence on the nutrition of Korean middle-aged adults through three complementary lenses: life-course epidemiology, the biology of nonlinear aging, and behavioral and community-based nutrition science. Rather than following a systematic protocol, sources were selected and organized to follow the conceptual progression of the review. The biological basis of midlife transition was addressed first, drawing on recent multi-omics and life-course studies. The epidemiology and nutritional status of Korean middle-aged adults were then examined using national health and nutrition data and disease-specific dietary studies, followed by disease-targeted dietary strategies for musculoskeletal, bone, cognitive, and cardiometabolic health and by large-scale Korean lifestyle-intervention trials. Throughout, peer-reviewed research was complemented by policy documents and major national cohort and intervention studies so that the resulting framework reflects both the scientific evidence and the policy context relevant to this life stage.

DYNAMICS OF BIOLOGICAL AGING

Although the primary focus of this review relies on Korean focused data, the following findings derived from a single, international longitudinal multi-omics cohort provide an essential hypothesis-generating framework

[7]. This specific overseas study is introduced because comparable cutting-edge multi-omics research tracking non-linear biological aging transitions is currently unavailable in domestic cohorts. A recent longitudinal study identified two pronounced “biological crests” of molecular change clustering around 44 and 60 years old [7]. This suggests that middle adulthood is not merely a stage of advancing chronological age but a biological transition period when metabolic pathways and disease risks fundamentally change. The findings were obtained after tracking 108 adults aged 25–75 for up to 6.8 years, analyzing tens of thousands of molecular markers—including transcriptomic, proteomic, metabolomic, lipidomic, and microbiome data—from blood, stool, skin, oral, and nasal samples (Table 1) [7].

These nonlinear dynamics provide a key biological rationale for age-appropriate nutritional intervention strategies in middle-aged adults. At the first inflection point, around age 44, molecular pathways governing lipid and alcohol metabolism undergo marked changes, coinciding with an accelerated risk of cardiovascular conditions such as hyperlipidemia, atherosclerosis, and coronary artery disease. Accordingly, nutritional strategies at the early-to-mid-40s should prioritize restoring the energy balance, improving lipid profiles through increased unsaturated fatty acid intake, restricting alcohol, and ensuring adequate antioxidant supply. At the second inflection point, around age 60, biomarkers related to immune regulation, carbohydrate metabolism, and kidney function are extensively restructured. This period marks the peak incidence of type 2 diabetes

and a clinical turning point for immunosenescence and musculoskeletal degeneration, including sarcopenia and osteoporosis. Nutritional strategies in the late 50s to early 60s should therefore emphasize high-quality protein intake to counter anabolic resistance, immunonutrition to dampen low-grade inflammation, and dietary patterns that enhance insulin sensitivity and limit rapid glycemic fluctuations.

Importantly, these implications should not be interpreted as definitive age-specific clinical guidelines, but as a translational framework that requires validation in larger, more diverse, and intervention-based studies. Nevertheless, the findings support a shift from a reactive model that treats diseases pharmacologically only after manifestation, toward a preventive model that seeks to maximize metabolic resilience before or during periods of pronounced biological change.

EPIDEMIOLOGY OF CHRONIC DISEASES IN KOREAN MIDDLE-AGED ADULTS

The 2024 Korea National Health and Nutrition Examination Survey (KNHANES IX-3) showed a strong age-dependency in the prevalence of major chronic conditions among Korean adults; however, individual conditions follow two distinct age trajectories (Fig. 1) [8]. Hypertension, hypercholesterolemia, and diabetes increase progressively, accumulating with advancing age, whereas obesity and hypertriglyceridemia peak in early midlife and decreases thereafter [8]. This divergence is most pronounced across the 40s–50s transition as shown in

Table 1. Nonlinear dynamics of multi-omics profiles during human aging

Biological aging crest	Approximate chronological age	Primary molecular & metabolic dysregulation	Clinical implications & associated risks
Crest 1 (early midlife transition)	44 years	Lipid metabolism Alcohol metabolism Structural proteins in the skin and muscle Cardiovascular disease pathways	Hyperlipidemia Early atherosclerosis Metabolic syndrome Decline in muscle elasticity Skin aging
Crest 2 (late midlife transition)	60 years	Immune regulation Carbohydrate metabolism Oxidative phosphorylation Kidney function pathways	Immunosenescence Type 2 diabetes onset Profound loss of bone mineral density (osteoporosis) Accelerated sarcopenia

Data from Shen *et al.* (Nat Aging 2024; 4(11): 1619-1634) [7].

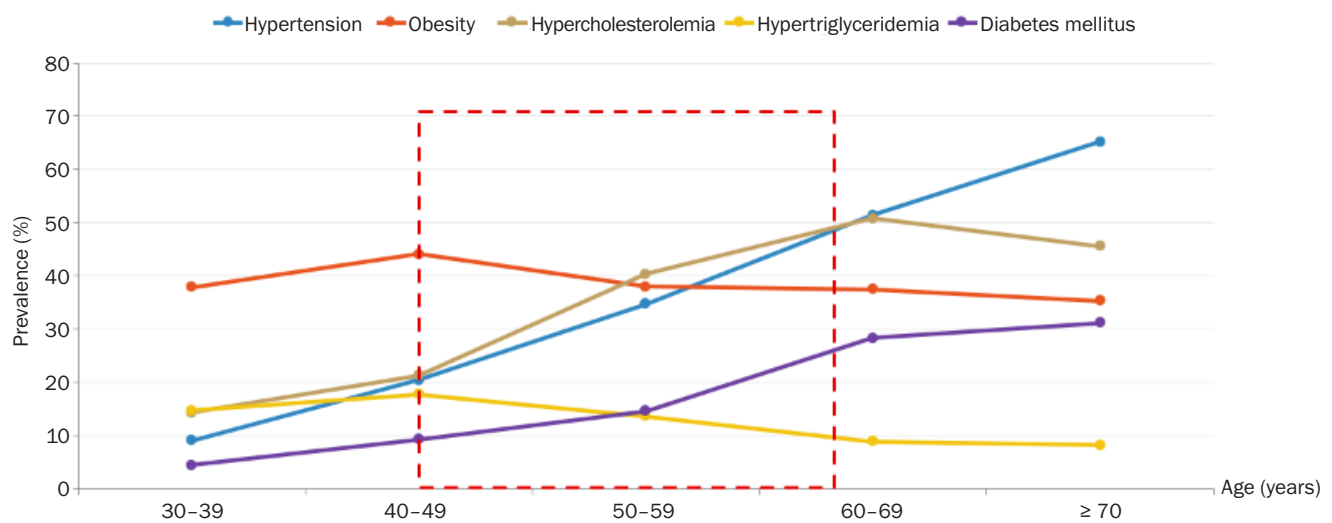


Fig. 1. Age-specific prevalence of chronic diseases. Adapted from Korea Health Statistics 2024: Korea National Health and Nutrition Examination Survey (KNHANES IX-3). Korea Disease Control and Prevention Agency, 2015 [8]. Hypertension: systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg, or use of antihypertensive medication. Obesity: body mass index BMI ≥ 25 kg/m² (Asia-Pacific criterion). Hypercholesterolemia: total cholesterol ≥ 240 mg/dL or use of cholesterol-lowering medication. Hypertriglyceridemia: fasting triglycerides ≥ 200 mg/dL. Diabetes mellitus (based on fasting glucose or HbA1c): fasting glucose ≥ 126 mg/dL, physician diagnosis, use of glucose-lowering medication or insulin, or HbA1c $\geq 6.5\%$.

Fig. 1 [8].

Hypertension exhibits the steepest, most consistent age gradient. Prevalence climbs from 9.1% among adults in their 30s to 20.4% in their 40s, 34.7% in their 50s, and 51.4% in their 60s—about a six-fold increase across the adult range. A marked inflection occurs between 40s–50s, when prevalence rises by 14.3 percentage points (%p), a relative increase of more than 70% within a single decade. Hypercholesterolemia follows a comparable but more front-loaded pattern. It increases modestly from 14.3% in the 30s to 21.3% in the 40s, then nearly doubles to 40.3% in the 50s (+ 19.0%p)—the single largest decade-to-decade increment for any condition in the survey. Then, prevalence peaks at 50.8% in the 60s before easing slightly to 45.6% at ≥ 70 years, a late-life plateau plausibly reflecting the combined effects of widespread lipid-lowering treatment and selective survival. Diabetes mellitus is uncommon in early adulthood (4.5% in the 30s) but accelerates from midlife onward, reaching 9.3% in the 40s and 14.6% in the 50s before sharply rising between the 50s and 60s (14.6% to 28.3%, a near-doubling).

In contrast, obesity is most prevalent in early-to-mid-adulthood, not increasing with age. Already high at

37.9% in the 30s, peaks at 44.1% in the 40s—the highest prevalence for this condition in any age group—gradually declining to 38.0%, 37.5%, and 35.3% across the 50s, 60s, and ≥ 70 groups. Hypertriglyceridemia displays the same early-peak on a lower scale, rising from 14.7% in the 30s to a maximum of 17.8% in the 40s before falling to 8.2% by ≥ 70 years. Across the life course, these patterns in the relative disease burden cross over. Obesity is the dominant metabolic abnormality in the 30s and 40s, when hypertension and diabetes remain comparatively low; by the 50s, hypertension and hypercholesterolemia overtake it; and from the 60s onward, hypertension is the single, most prevalent condition. Thus, the 40s and 50s are a decisive transition window, during which the predominantly metabolic risk profile of younger adults translates into the cardiovascular and metabolic disease burden of later life. Accordingly, middle age is a critical period for screening and preventive intervention.

IMBALANCE BETWEEN ENERGY INTAKE AND REQUIREMENTS AND DIET QUALITY DECLINE

Comparing the habitual intake of Korean middle-aged adults (KNHANES 2013–2022) with 2025 Korean Dietary

Reference Intakes (KDRI) reveals a consistent paradox: energy and protein levels are adequate to high but micronutrient intake is widely insufficient; moreover, several of these patterns differ markedly between men and women [8, 9] (Tables 2 and 3).

Energy and macronutrient intake

In men, mean energy intake closely tracks the estimated energy requirement (EER), approximating 2,500 kcal/d at 30–49 years and 2,100–2,200 kcal/d at 50–64 years. Protein intake is high—88.8 and 80.6 g/d, respectively—exceeding the recommended nutrient intake (RNI) of 60–65 g/d; nevertheless, 13.8% of men aged 30–49 and

21.1% of those aged 50–64 were below the reference, a nontrivial minority of concern given the anabolic resistance and accelerating sarcopenia risk observed at this life stage [9]. Fat contributes 16.7%–20.7% of the total energy, within the acceptable macronutrient distribution range (AMDR, 15%–30%) but drifting toward its lower edge with age, whereas saturated fat levels are generally under the chronic disease risk reduction (CDRR) threshold of 7% of energy. Total sugar intake (60.8–63.3 g/d) was below the goal of 20% of total energy.

In women, the energy intake is slightly below the EER at 30–49 years ($\approx 1,800$ – $1,900$ kcal/d), falls short at 50–64

Table 2. Nutrient intake status of Korean men aged 30–64 relative to 2025 KDRI

Nutrient	Age (year)	DRI	Mean intake (based on KNHANES 2013–2022)	Below the KDRI (%)
Energy (kcal/d)	30–49	EER: 2,500	$\sim 2,500$	-
	50–64	EER: 2,200	$\sim 2,100$ – $2,200$	-
Protein (g/d)	30–49	RNI: 65 EAR: 50	88.8	13.8
	50–64	RNI: 60 EAR: 50	80.6	21.1
Fat (%/E)	30–49	AMDR: 15–30	20.7	-
	50–64		16.7	-
Saturated fatty acid (%/E)	19–64	CDRR: < 7%	Generally < 7%	-
Sugars (g/d)	30–49	Goal: < 20% of total energy	63.3	-
	50–64		60.8	-
Calcium (mg/d)	30–49	RNI: 800 EAR: 650	495.7 (median)	71.4
	50–64	RNI: 750 EAR: 600	517.0 (median)	64.6
Vitamin D ($\mu\text{g}/\text{d}$)	30–49	AI: 10	3.5	92.6
	50–64		4.0	92.1
Vitamin A (μg RAE/d)	30–49	RNI: 800 EAR: 560	410.6	78.8
	50–64	RNI: 750 EAR: 530	458.8	74.4
Riboflavin (mg/d)	30–49	RNI: 1.5	1.91	29.0
	50–64	EAR: 1.3	1.75	34.1%
Sodium (mg/d)	30–49	AI: 1,500 CDRR: 2,300	4,026.0	Above CDRR: 83.4 Below AI: 5.0
	50–64		3,942.2	Above CDRR: 79.4 Below AI: 5.3

KNHANES, Korean national health and nutrition examination survey; KDRI, Korean Dietary Reference Intake; EER, estimated energy requirement; RNI, recommended nutrient intake; EAR, estimated average requirement; AMDR, acceptable macronutrient distribution range; CDRR, chronic disease risk reduction intake; AI, adequate intake.

Table 3. Nutrient intake status of Korean women aged 30–64 relative to 2025 KDRI

Nutrient	Age (year)	DRI	Mean intake (based on KNHANES 2013–2022)	Below the KDRI (%)
Energy (kcal/d)	30–49	EER: 1,900	~1,800–1,900	-
	50–64	EER: 1,700	~1,500–1,600	-
Protein (g/d)	30–49	RNI: 50 EAR: 40	59.5	24.2
	50–64	RNI: 60 EAR: 50	59.3	22.6
Fat (%/E)	30–49	AMDR: 15–30	21.1	-
	50–64		17.5	-
Saturated fatty acid (%/E)	19–64	CDRR: < 7%	Generally < 7%	-
Sugars (g/d)	30–49	Goal: < 20% of total energy	50.8	-
	50–64		61.5	-
Calcium (mg/d)	30–49	RNI: 700	397.1 (median)	74.0
	50–64	EAR: 580	437.1 (median)	72.8
Vitamin D (µg/d)	30–49	AI: 10	2.6	95.6
	50–64		3.1	95.5
Vitamin A (µg RAE/d)	30–49	RNI: 650 EAR: 450	350.2	76.2
	50–64	RNI: 600 EAR: 430	379.6	70.7
Riboflavin (mg/d)	30–49	RNI: 1.2	1.41	31.0
	50–64	EAR: 1.0	1.40	29.1
Sodium (mg/d)	30–49	AI: 1,500 CDRR: 2,300	2,722.6	Above CDRR: 55.4 Below AI: 17.5
	50–64		2,769.2	Above CDRR: 55.6 Below AI: 17.5

KNHANES, Korean national health and nutrition examination survey; KDRI, Korean Dietary Reference Intake; EER, estimated energy requirement; RNI, recommended nutrient intake; EAR, estimated average requirement; AMDR, acceptable macronutrient distribution range; CDRR, chronic disease risk reduction intake; AI, adequate intake.

years (~1,500–1,600 kcal/d against an EER of 1,700 kcal/d). Mean protein intake (~59 g/d) exceeds the RNI, but the prevalence of shortfall is higher than in men—24.2% at 30–49 years and 22.6% at 50–64 years—pointing to an issue with protein quality and per-meal distribution rather than gross deficiency. Fat levels (17.5%–21.1% of energy) fall within the AMDR. Notably, sugar intake increases with age, from 50.8 to 61.5 g/d; although still within the 20% energy goal.

Mineral and micronutrient status

The most striking and clinically consequential concern is micronutrients intakes. Calcium intake is severely inadequate in both genders: median intakes of 496–517 mg/d in men and 397–437 mg/d in women were under the 700–800 mg/d RNI, leaving 65%–71% of men and

73%–74% of women below the reference. Vitamin D deficiency was even more striking—mean of 3.5–4.0 µg/d and 2.6–3.1 µg/d intake in man and women, respectively against an adequate intake of 10 µg/d mean that > 90% of men and around 95% of women fail to meet the standard. This concurrent calcium–vitamin D insufficiency is especially alarming for women approaching and beyond menopause, in whom it compounds with declining estrogen levels, accelerating bone loss. Vitamin A is likewise inadequate, with 71%–79% of adults below the RNI; riboflavin is the least problematic: mean intakes exceed the RNI, although around 30% of adults still do not meet daily requirements.

Sodium shows the opposite direction. Men consume 4,026 mg/d, and 79%–83% exceed the CDRR of 2,300 mg/d; women consume less (~2,700–2,770 mg/d) but still sur-

pass the CDRR in 55% of cases. This pronounced gender difference reflects men's heavier reliance on soups, stews, and eating out.

Together, these data delineate the “triple burden” of mid-life nutrition—adequate-to-excess energy and protein, widespread deficits in bone- and immune-related micronutrients, and excessive sodium—and indicate that intervention should prioritize calcium and vitamin D repletion, sodium reduction (particularly in men), and adequate protein levels for the minority not meeting daily requirements, rather than overall caloric restriction alone.

DIET QUALITY AND CHRONIC DISEASE RISK IN KOREAN MIDDLE-AGED ADULTS

The Korean Healthy Eating Index (KHEI), developed by the Korea Disease Control and Prevention Agency to comprehensively evaluate diet quality, is a key indicator of the relationship between diet and chronic diseases in middle-aged adults [10]. The KHEI consists of 14 items (maximum score, 100), including eight items on the adequacy of recommended foods (mixed grains, fruits, vegetables, milk and dairy, meat/fish/eggs/legumes), three on the moderation of restricted foods (saturated fat, sodium, and sugars), and another three on energy balance.

An analysis of KNHANES data (2016–2018) involving 4,113 middle-aged adults living in single-person households (1,517 men, 2,596 women) found that higher KHEI scores were significantly associated with a lower risk of metabolic abnormalities such as obesity, hypertension, and hypertriglyceridemia [11]. Notably, this study demonstrated that household type (multi-person vs. single-person) is a strong structural factor mediating diet quality and disease risk. Men in single-person households had significantly lower total KHEI scores than those in multi-person households ($P < 0.0001$). Among men in single-person households, those in the lowest tertile of KHEI scores (T1) had a 4.625 times higher risk of obesity, 3.790 times higher risk of hypertension, and 4.333 times higher risk of hypertriglyceridemia than those in the highest tertile (T3). For women, the odds ratios (OR) for obesity and hypertriglyceridemia in the lowest KHEI tertile within single-person households

skyrocketed to 3.223 and 7.134, respectively. Additionally, in an analysis of 9,161 adults aged 19–64 years (3,985 men, 5,176 women) from the 2022–2023 KNHANES, a higher total KHEI score was associated with a lower risk of metabolic syndrome (MetS) in men (OR, 0.658). Among the three domains, Adequacy was the strongest predictor: participants in the highest-scoring group showed significantly reduced odds of MetS in both men (OR, 0.689) and women (OR, 0.665). Within the Adequacy domain, scores for breakfast, fruit, and milk/dairy intake were lower in the MetS group, whereas the Moderation domain showed a gender-specific pattern (with women in the highest-scoring group showing an increased risk), and the Balance domain was generally not associated with MetS [12].

Consumption patterns of fermented foods also influence inflammation levels and chronic diseases. A latent profile analysis of 7,111 middle-aged adults (40–64 years) using KNHANES (2015–2018) showed that people with a fermented grain-centered pattern (FGP) and fermented dairy-centered pattern had lower levels of high-sensitivity C-reactive protein than the low fermented-food pattern group, indicating lower micro-inflammation [13]. The FGP group demonstrated significant risk reductions with an OR of 0.810 for hypertension and 0.586 for diabetes, confirming that an appropriate combination of high-quality traditional fermented foods and dairy products can help prevent metabolic diseases in middle-aged adults.

Taken together, the lower adequacy scores for breakfast, fruit, and dairy among those at higher metabolic risk—and the elevated risk observed among adults living alone—suggest that these dietary gaps reflect more than personal motivation. Rather, they indicate that nutritional management is structurally shaped by socio-environmental factors such as living arrangements, food accessibility, and cooking skills, rather than by individual choice alone.

TAILORED NUTRITIONAL STRATEGIES FOR PHYSIOLOGICAL TRANSITIONS

The two biological inflection points in middle adulthood clinically manifest as four core physiological regressions: muscle mass loss, decreased bone mineral den-

sity, cognitive decline, and cardiometabolic alterations [14–17]. Purposeful dietary strategies to delay these effects and actively alter health trajectories are crucial [18]. In a recent study, nutritional recommendations were developed across several health domains—glycemic control, cardiovascular health, cognitive function, muscle function, and skin health—that represent functions commonly compromised with aging [19] some of which are presented below.

Musculoskeletal health: protein and macronutrient strategies to overcome sarcopenia

Sarcopenia is not merely a result of aging but a critical pathological starting point leading to insulin resistance and MetS [20]. Since human skeletal muscle is the body's largest glucose reservoir (absorbing around 80% of total glucose) and a fat-burning organ, muscle mass decline leads to elevated blood sugar levels and visceral obesity [21]. In a nationally representative cross-sectional analysis of 15,586 Korean adults aged ≥ 30 years using whole-body dual-energy X-ray absorptiometry (KNHANES IV–V, 2008–2011), mean appendicular skeletal muscle mass (ASM) declined progressively with advancing age, with a markedly steeper decline in men than in women. Relative to adults aged 30–49 years, mean ASM in men decreased from 23.3 kg to 21.5 kg in the 50–69-year group (–7.7%) and to 19.1 kg in those aged ≥ 70 years (–18.0%); the corresponding values in women were 14.8 kg, 14.4 kg (–2.7%), and 13.1 kg (–11.5%) [22].

The frontline defense against sarcopenia is high-quality protein intake. Previously, the RNI for protein in adults was 0.91 g/kg/day, but recent large-scale clinical and epidemiological studies have shown that this standard may be insufficient to optimize muscle maintenance in older adults to prevent the catabolism of aging muscles [23]. Since aging causes “anabolic resistance,” larger amounts of amino acids are needed to activate muscle protein synthesis. Accordingly, an expert consensus by the Korean Geriatric Society and the Korean Nutrition Society suggested a dietary protein intake of at least 1.2 g/kg/day for Korean older adults, which is higher than the general adult RNI of 0.91 g/kg/day [24].

Furthermore, a systematic review on sarcopenia diagnostic indicators and protein intake revealed that Korean older adults with low protein intake had a signifi-

cantly higher risk of decreased grip strength and muscle mass [25]. However, the foundation for preventing such severe muscle loss in older adulthood must be established much earlier. The progressive decline in skeletal muscle mass and function, which eventually leads to sarcopenia, can begin as early as the fourth or fifth decade of life. Since muscle mass typically decreases by approximately 1% per year starting around age 50, middle age serves as a critical transition phase. Therefore, relying solely on increased protein interventions after reaching old age may not be sufficient to fully counteract anabolic resistance and muscle degradation. Instead, adopting an optimal dietary protein strategy and building muscle reserves during middle age is essential to delay the onset of sarcopenia and maintain musculoskeletal health in later years (Table 4) [26–28].

Not only the absolute protein amount but also its quality and amino acid composition are important. Branched-chain amino acids (BCAAs), particularly leucine, directly stimulate the mTORC1 pathway to induce muscle synthesis [26]. Incorporating a mixed protein diet comprising high-quality plant-based proteins like soy and legumes alongside animal-based proteins provides the dual benefit of meeting essential amino acids requirements while lowering saturated fat and cholesterol absorption, thereby reducing cardiovascular risk [27]. Moreover, combining protein with vitamins and minerals significantly amplifies musculoskeletal mass preservation compared to protein alone [28].

Osteoporosis and bone health management: nutritional buffering for the menopausal transition

Middle-aged women experience a sharp decline in estrogen after menopause, leading to the loss of defensive mechanisms that previously inhibited osteoclast activity. Consequently, the microarchitecture of the trabecular bone is destroyed and bone mass rapidly lost [29]. According to Korean statistics, the prevalence of osteopenia among women over 50 is 47.9%, and that of osteoporosis is 22.4%, with these rates doubling for every 10-year increase in age [30].

Nutritional strategies for osteoporosis prevention must extend beyond supplementing a single nutrient (calcium) to modulating overall dietary patterns and the body's inflammatory environment. A large-scale

Table 4. Key micronutrients and macronutrients for sarcopenia prevention

Target nutrient	Recommended intake dose for muscle preservation	Physiological role in middle-aged adults
Total dietary protein	1.2–1.5 g/kg/day (or 25–30 g/meal)	Overcomes anabolic resistance and provides primary building blocks for muscle protein synthesis
Leucine (branched-chain amino acids)	2.5–3.0 g/meal	Direct activator of the mTORC1 signaling pathway, initiating muscle anabolism
Vitamin D	800–1,000 IU/day	Upregulates intramuscular vitamin D receptors and enhances fast-twitch muscle fiber function
Magnesium	300 mg/day (men), 270 mg/day (women)	Co-factor in ATP synthesis and insulin signaling; mitigates age-related muscle mass loss
Vitamin C/E	45–90 mg/day (vitamin C), 400 IU/day (vitamin E)	Decreases reactive oxygen species that exacerbate age-related muscle catabolism

Data from Kamei *et al.* (Nutrients 2020; 12(1): 261) [26].

Data from Guasch-Ferré *et al.* (Circulation 2019; 139(15): 1828-1845) [27].

Data from Nasimi *et al.* (Adv Nutr 2023; 14(4): 762-773) [28].

epidemiological study on KNHANES (2008–2010) data showed a strong correlation between the dietary patterns of Korean postmenopausal women and bone health. A total of 3,735 Korean postmenopausal women found that a “dairy and fruit” dietary pattern—high in milk, dairy products, and fresh fruits—was associated with a 53% lower risk of lumbar-spine osteoporosis (OR 0.47, 95% confidence interval 0.35–0.65), whereas a traditional “white rice, *kimchi* and seaweed” pattern was associated with poorer bone health (OR 1.40) [31].

Furthermore, the bone metabolism is highly sensitive to the body’s inflammatory environment. A study applying the dietary inflammatory index (DII), which quantifies the inflammatory potential of a diet, found that postmenopausal women in the group with the highest DII (a pro-inflammatory diet)—characterized by high proportions of refined carbohydrates, processed meats, and saturated fats—had significantly lower bone mineral density in the femoral neck than the control group, and a 1.27 times higher OR for osteopenia/osteoporosis [32]. Conversely, a cross-sectional study of postmenopausal Korean women found that a higher intake frequency of vegetable-derived antioxidant micronutrients was positively associated with bone mass in a site-specific manner— β -carotene with the lumbar spine T-score, vitamin C with the femoral neck T-score, and zinc with the total hip T-score. Given its cross-sectional design, however, these results indicate associations rather than causal relationships [33]. This demonstrates that an antioxidant and anti-inflammatory diet is essen-

tial for collagen synthesis in the bone matrix and osteoclast inhibition.

Preventing cognitive decline and neuroprotection: the MIND diet

After the second biological inflection point, around age 60, inflammatory responses and oxidative stress in cranial nerve cells accumulate, gradually increasing the risk of developing dementia, including Alzheimer’s disease [34]. The most globally recognized nutritional intervention for preserving cognitive function is the MIND, developed by Morris *et al.* [35] in 2015. The MIND diet combines the cardiovascular-friendly DASH diet and the Mediterranean diet. It is intricately designed to maximize the intake of specific food groups, polyphenols, and omega-3 fatty acids, which have neuroprotective effects. Long-term epidemiological research demonstrated that groups strictly adhering to the MIND diet saw a staggering 53% reduction in Alzheimer’s risk, while even moderate adherence resulted in a 35% risk reduction [36]. Notably, the cognitive decline rate of the group in the top tertile of MIND scores showed a protective effect equivalent to being 7.5 years younger compared to the bottom tertile (Table 5).

Cardiometabolic disease prevention: DASH and Mediterranean diets

To address the abnormalities in lipid metabolism and cardiovascular disease pathways that develop around the mid-40s, the overall dietary pattern needs to be

Table 5. Mediterranean-DASH Intervention for Neurodegenerative Delay (MIND) diet components for cognitive preservation

Dietary component	MIND diet recommendation	Neuroprotective mechanism
Green leafy vegetables	≥ 6 servings/week	Rich in folate, lutein, and vitamin K; suppresses neuroinflammation and maintains synaptic plasticity
Berries	≥ 2 servings/week	Contains anthocyanins that promote neural signal transmission in the cerebral cortex and defend against oxidative stress
Extra virgin olive oil	Primary cooking fat	Oleocanthal activates the clearance of amyloid-beta (Aβ) plaques, which induce Alzheimer's
Nuts & fish	Nuts ≥ 5 servings/week Fish ≥ 1 serving/week	Omega-3 (EPA, DHA) unsaturated fatty acids preserve brain cell membrane fluidity and protect microvessels
Red meat & fast food	Red meat < 4 servings/week Fried food < 1 serving/week	Blocks generation of saturated fats and advanced glycation end-products, preventing damage to blood-brain barrier permeability

adaptable and cardiovascular-friendly. The DASH diet, designed for hypertension prevention and management, focuses on increasing intake of whole grains, fruits, vegetables, and low-fat dairy products while limiting red meat, sodium, and sugar-sweetened beverages [37]. It lowers blood pressure through a complex interaction between micronutrients with excellent vasodilatory and sodium-excreting functions, such as dietary fiber, potassium, calcium, and magnesium.

The Mediterranean diet also actively recommends daily or weekly consumption of polyphenol-rich plant foods (extra virgin olive oil, nuts, seeds, and legumes) and omega-3-rich fish [38]. In large population-based studies of adults, a higher intake of dietary antioxidant nutrients—including vitamins A, C, and E, carotenoids, selenium, and zinc, commonly summarized as the composite dietary antioxidant index—has been inversely associated with atherosclerotic cardiovascular disease and its estimated 10-year risk, plausibly through antioxidant and anti-inflammatory mechanisms [39]. As these findings derive from observational data, they indicate association rather than causation. Conversely, high-fat processed meats like bacon and sausages, or excessive refined carbohydrate intake, act as a catalyst for MetS and must be limited from the diet.

Precision nutrition management for metabolic syndrome and prediabetes

Prolonged obesity and insulin resistance progress to prediabetes. This is a “warning stage” before type 2 diabetes and the final “reversible window” to return to normal blood glucose levels through intensive lifestyle modification (LSM) [40]. Compared to Westerners, Ko-

reans have a lower insulin secretory capacity of pancreatic beta cells and a higher abdominal visceral fat ratio, leading to a sharp increase in diabetes risk even at a relatively low body mass index (BMI). Instead of blindly following Western guidelines, a precision nutritional management tailored to Korean food culture and body type is needed [41].

The KDPS, a large-scale, multicenter prevention study led by the Korean Diabetes Association, was conducted to find the optimal diabetes prevention solution for Koreans [42]. Based in university hospitals and community public health centers nationwide, the KDPS recruited overweight/obese patients with prediabetes aged 30–70 and randomly assigned them to a standard management group, an LSM group, and a metformin group and were prospectively tracked. The core goal for the LSM group was to lose ≥ 5% of their initial body weight within 6 months and maintain it through systematic nutritional management and behavioral psychological correction. The results were encouraging. The group that received the community (public health center)-based internet-linked LSM intervention for 16 weeks to 6 months showed significant reductions in body weight and BMI and dramatic improvements in fasting blood glucose and insulin resistance indicators compared to the control group. Notably, in the hospital-based H-KDPS cohort, the intensive LSM group showed a 49% higher inhibitory effect on the onset of type 2 diabetes compared to the standard management group. This suggests that a close-contact dietary and behavioral correction program led by trained experts (public health center staff, dietitians) is overwhelmingly more effective for chronic disease prevention than single nutrient prescriptions or

drug administration.

SYSTEMS-CENTERED, COMMUNITY-LINKED NUTRITION MODEL FOR MIDDLE-AGED ADULTS

While individual dietary guidelines and one-off health center education can have a significant impact, the current food environment is simply too complex to sustain lifelong healthy eating habits.

Building a community ecosystem around the workplace and local services

In Korea, public nutrition and welfare services are largely organized around older adults, and many community resources are activated only after age 65. As a result, adults in their 40s and 50s—often at the peak of their economic and caregiving responsibilities—frequently fall into a structural gap where their daily nutrition is left to individual willpower in the face of long working hours, occupational stress, company dinners, food delivery culture, and chronic sleep deprivation. By the time they become eligible for elderly-focused programs such as long-term care insurance, dementia centers, or senior meal services, sarcopenia and MetS may already have caused partly irreversible damage [43].

To address this midlife service gap, a community ecosystem that actively links the workplace, local public health centers, primary care clinics, and the home environment is essential. Rather than treating middle-aged adults as a “pre-elderly” group who will be supported later, nutrition support should be embedded where they actually spend most of their time and make food choices—at work and in their immediate communities.

Workplace and enterprise-centered environmental design

Following nutrition guidelines (sodium reduction, Mediterranean/DASH-based meal options) should be mandatory in corporate cafeterias. Company health promotion programs should evolve beyond simple health check-ups to community health center-level LSM programs, encouraging employee participation.

Expansion of preventive interventions in community health services

Building on evidence from KDPS and similar projects,

digital and face-to-face interventions led by dietitians and health professionals in public health centers and primary care clinics should be scaled up and explicitly opened to middle-aged adults, not only to older seniors. Incorporating the Adult Nutrition Quotient (NQ-A) into routine check-ups could help identify high-risk individuals early and connect them to proactive nutritional coaching and community programs.

In this community-linked ecosystem, digital health tools and precision nutrition technologies can act as a continuous support layer that connects the workplace and local services to individuals’ everyday decision-making, rather than functioning as stand-alone apps.

CONCLUSIONS

Middle adulthood is a decisive life transition period over the life course that determines the quality of life and healthspan in old age. As shown by multi-omics research, human aging is not a gradual process but an explosive nonlinear sequence where lipid metabolism, immune, and musculoskeletal pathways abruptly change in the mid-40s and early 60s. Korean epidemiological data on chronic diseases warn the intersection of these biological fluctuations with the triple burden of malnutrition, it results in chronic diseases such as obesity, diabetes, and cancer.

The core of successful nutritional strategies for this life transition period is supplying sufficient protein and BCAAs prevent sarcopenia. Second, rapidly transitioning to disease-targeted dietary structures—such as increased dairy and fruit consumption, the Mediterranean and the MIND diet—could help against osteoporosis and cognitive decline. Third, actively adopting and practicing age-tailored, community-based LSM to revert the risk of prediabetes.

Ultimately, these strategies cannot rely on individual willpower or isolated educational campaigns alone. To close the current midlife service gap, it will be crucial to build a systems-centered, community-linked ecosystem in which workplaces, public health centers, and primary care clinics coordinate nutrition support across the environments where middle-aged adults actually live and work. Together, these approaches can better support

Korean middle-aged adults in preventing chronic disease and achieving healthy longevity in an aging society.

As a narrative rather than systematic review, this work is subject to selection bias and may not capture all relevant domestic and international studies. In addition, the evidence base is dominated by observational data from Korean national surveys and cohorts, which constrains causal interpretation and limits extrapolation to other settings. Finally, few long-term intervention or multi-omics studies have rigorously tested community-linked precision nutrition strategies in middle-aged adults, highlighting the need for future trials and implementation research to refine and validate these approaches in real-world practice.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

This narrative review is based on previously published literature and does not contain original data.

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Research Article

Current status of sodium provision and reduction management in South Korean school meals: a descriptive study

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Objectives: This study investigated the current status of sodium provision and reduction management in South Korean school meals.

Methods: Using a proportional stratified random sampling by school level (kindergarten and elementary, middle, and high school), location (urban, rural, and island/remote area), and region (17 metropolitan and provincial Offices of Education), 1,068 schools (about 10% of all schools) were selected from 430 kindergartens and 5,883 elementary, 2,501 middle, and 2,268 high schools using the school meal system of the National Education Information System. An online survey was conducted with nutrition teachers and dietitians at the selected schools from September to November 2021 (n = 608; response rate: 57%).

Results: About 26.6% of schools had not established sodium provision standards. More than half of the respondents (59.9%) had never used low-sodium products; this percentage increased with school level. The reasons given included “insufficient information” (46.7%) and “high prices” (41.5%). The level of consideration for sodium management was highest at the cooking stage (3.89/5.00 points) and lowest at purchasing stage (3.20 points). Cooking-related consideration was significantly higher in kindergartens and elementary schools than in middle and high schools, while purchasing-related consideration was significantly higher in elementary than in middle schools. To reduce sodium, the most commonly reported requirement was “reduction of the excessive foodservice workload” (4.48/5.00 points), followed by “support for educational materials” (4.31 points).

Conclusion: Reducing sodium intake in school meals may require establishing clear sodium standards, increasing the availability of low-sodium products, easing the excessive workload, and enhancing educational support. To support these efforts, more comprehensive and consistently implemented policy approaches may be needed to reduce sodium in schools.

Keywords: schools; food services; sodium; surveys and questionnaires; nutritionists

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INTRODUCTION

The average daily sodium intake among the South Korean population aged 1 year or older has steadily declined from 3,848 mg in 2013 to 3,030 mg in 2022 [1]. Despite the steady decline, sodium intake among children and adolescents in South

Korea still remains excessively high. The World Health Organization (WHO) recommends that sodium intake for children aged 2–15 years be lower than the adult maximum (2,000 mg/day), adjusted downward based on their energy requirements [2]. Although WHO does not specify absolute sodium intake values for each age within this range, several pediatric nutrition guidelines and public-health institutions suggest age-adjusted upper limits: for instance, less than 1,200 mg/day for ages 1–3 years; less than 1,500 mg/day for ages 4–8 years; less than 1,800 mg/day for ages 9–13 years [3]. Using these age-adjusted benchmarks as a reference, current school meal sodium provision levels appear far higher than recommended, underscoring the need for stronger sodium-reduction policies in school foodservice settings.

Excessive sodium consumption is closely associated with various health conditions, including hypertension, cardiovascular diseases, and gastric cancer [4, 5]. Given that dietary habits established during childhood often persist into adulthood [6, 7], it is essential to cultivate healthy eating behaviors early in life such as offering less salty foods and gradually adapting children to lower-sodium tastes—may contribute to healthier lifelong dietary behaviors [8, 9].

School meals play a significant role in shaping diet and dietary habits during childhood and adolescence, which in turn influence health behaviors in adulthood [10–12]. However, school meals are often high in sodium. In one study conducted in elementary and middle schools in Incheon and Gangwon-do, the average sodium intake from school meals was 802 mg and 1,056 mg, respectively—accounting for 40% and 52% of the WHO's recommended daily sodium intake of 2,000 mg. As these figures reflect intake, the actual sodium content of the meals was even higher. Notably, sodium levels per menu item were higher in elementary school meals than in those served at the middle school level [13]. Several other studies have reported similar findings regarding sodium intake or provision through school meals [14–16], further emphasizing the need to reduce sodium levels in school meals.

In 2013, the Ministry of Education conducted a survey on sodium intake from school meals at 30 schools located in Seoul, Gyeonggi-do, and Incheon. The results revealed high levels of sodium intake, averaging 1,155

mg per meal—911 mg in elementary schools, 1,099 mg in middle schools, and 1,454 mg in high schools [17]. In response, the Ministry of Education published the “*Guide to Reducing Sodium in School Meals*” [18], which outlined strategies for sodium reduction in school meal programs. As part of these guidelines, the Ministry of Education established target sodium levels per meal of 900 mg for elementary schools, 1,000 mg for middle schools, and 1,300 mg for high schools. The target sodium levels were established on a per-meal basis because students in South Korea typically eat one lunch meal at school. When determining these targets, the Ministry of Education considered the actual sodium intake levels at the time and aimed to achieve an approximately 2%–10% reduction in sodium content in school meals by 2017 through gradual implementation. In addition, recommended salinity levels for soups and stews were set at 0.6% for elementary and middle schools and 0.7% for high schools [17]. These sodium reduction guidelines were not mandatory, but rather provided as national recommendations to promote gradual sodium reduction in school meals. Compliance depended largely on the operational capacity and discretion of individual schools and local education offices. Similar voluntary approaches have been implemented in other countries, showing varying levels of success. For example, the United States (US) phased in sodium reduction targets in the National School Lunch Program, which resulted in a significant decrease in sodium content in school meals over time [19, 20].

However, since 2013, no nationwide survey has been conducted to assess the status of sodium management in school meals, and thus, it remains unclear whether the target sodium levels established at that time have been effectively implemented. Although a national survey of school meal nutrition teachers and dietitians was conducted in 2013 to examine their awareness, practices, and strategies related to sodium reduction [21], few subsequent studies have investigated sodium reduction management from a national perspective. Most existing studies have been limited to specific regions, such as Gyeonggi-do and Daegu [13, 22–25]. In order to revise the sodium provision guidelines for school meals and develop effective sodium reduction strategies, it is essential to obtain an accurate understanding of the cur-

rent status of sodium provision and management. Such data will serve as a foundational resource for policy development and implementation.

Previously, the School Meals Act applied only to elementary, middle, and high schools; however, in 2021, kindergartens were officially included within its scope [26]. While there has been active research on sodium provision and management in meals served at day-care centers [22, 27, 28], studies specifically addressing sodium management in kindergarten meals remain extremely limited. Therefore, to establish effective strategies for sodium reduction through school meals, a comprehensive nationwide assessment, including kindergartens, is urgently needed to better understand the current status of sodium management in school meal services.

Therefore, this study aimed to investigate the current status of sodium provision and reduction management in school meals by conducting a survey of nutrition teachers and dietitians, who are responsible for school meal operations and play a key role in influencing meal quality and students' dietary habits. Specifically, the objectives of this study were to (1) assess the current practices related to sodium reduction management in school meals across different school levels, and (2) provide foundational data to inform the development of specific and practical strategies for reducing sodium content in school meals.

METHODS

Ethics statement

Informed consent was obtained from all participants prior to their voluntary participation in the study. This study was approved by the Institutional Review Board of Kongju National University (IRB No. KNU_IRB_2021-103).

1. Study design

This was a descriptive study. It was described according to the STROBE statement (<https://www.strobe-statement.org/>).

2. Survey participants

This study was conducted as an exploratory nationwide survey to assess the current status of sodium-reduction

practices in school meal settings. Among the 11,082 schools registered in the National Education Information System (NEIS) database nationwide—430 kindergartens, 5,883 elementary schools, 2,501 middle schools, and 2,268 high schools—we selected a sample of 1,068 schools (41 kindergartens, 567 elementary schools, 241 middle schools, and 219 high schools), representing approximately 10%. This sample was selected using a proportional stratified random sampling method, considering the proportion of number of schools by school level (kindergarten vs. elementary school vs. middle school vs. high school), school location (urban vs. rural vs. island/remote area), and region (17 metropolitan and provincial Offices of Education).

From September 28, 2021, to November 12, 2021, an online questionnaire was distributed to nutrition teachers or dietitians from the sample of schools. School meal services in Korean kindergartens and elementary, middle, and high schools are operated by either nutrition teachers or dietitians. Since the implementation of the nutrition teacher system in 2008, some schools have newly appointed nutrition teachers in charge of school meals, while in other schools, dietitians who were previously employed continue to manage school meal operations. In other words, each school is staffed with either a nutrition teacher or a dietitian. A nutrition teacher is a certified educator who not only manages school meals but also provides nutrition education as part of the formal curriculum. In contrast, a dietitian mainly manages school meals, and although they may engage in some educational activities, teaching is not considered one of their core duties.

The study included 608 participants (25 kindergartens, 323 elementary schools, 136 middle schools, and 124 high schools). The response rates were 61.0% for kindergartens, 57.0% for elementary schools, 56.4% for middle schools, and 56.6% for high schools, with an overall response rate of 57.0%. A chi-square test revealed no statistically significant differences between the number of responding and non-responding schools by school level ($P = 0.303$).

3. Survey content

The questionnaire was developed based on previous studies on sodium reduction [17, 21, 29, 30]. The sur-

vey addressed several aspects of sodium provision and management in school meals. It covered the status of sodium provision (6 items), including the establishment of sodium provision standards, the availability and frequency of salinometer use, and the establishment of standard meal portion sizes per person. It also examined sodium reduction management (5 items), including the organization of sodium reduction events, the use of low-sodium products, methods for measuring salinity, and the level of sodium management at each stage of school meal preparation. The level of sodium management was measured using a 5-point Likert scale (1: not at all considered–5: highly considered).

The survey also covered the status of sodium reduction education (3 items), including participation in education, provision of education, and methods of education. Sodium-related awareness was also covered (3 items), such as awareness of the saltiness of food, awareness of the amount of sodium in each menu item, and perception related to sodium (interest, necessity, difficulty in implementation). The level of perception related to sodium was measured using a 5-point Likert scale (1: not at all interested/necessary/difficult–5: very interested/necessary/difficult). Reasons for difficulty in reducing sodium and sodium-related requirements were also covered (2 items). The level of support requirements related to sodium management was measured using a 5-point Likert scale (1: not at all necessary–5: very necessary). General characteristics of the participants and schools (12 items in total), including sex, age, school level, and meal type, were also recorded. Before the main survey, a pilot survey was conducted with practicing five nutrition teachers, and the questionnaire content was amended and augmented based on those results.

In this survey, “establishment of sodium provision standards” was defined as having a criterion for sodium content (mg) per meal in the school foodservice. “Awareness of the amount of sodium in each menu item” was defined as knowing the amount of sodium (salt) for each menu item. In addition, “use of low-sodium products” was defined as using sodium-reduced products, such as low-sodium soy sauce, low-sodium red pepper paste, low-sodium seasonings, and low-sodium processed foods.

4. Data analysis

All data were analyzed according to school level. Because school meal programs in South Korea differ markedly by school level in terms of policy guidelines, budget allocations, staffing arrangements, operational structures, menu standards, cooking facilities, nutrition education practices, and overall meal service environments, the data were analyzed by school level. Significant differences in the distributions were evaluated using the χ^2 test, and differences in the means were tested using one-way analysis of variance and the Duncan *post hoc* test. SPSS Package Program (version 26.0; IBM Corp.) was used to perform all statistical analyses, the threshold for statistical significance was $P < 0.05$.

RESULTS

1. General characteristics

Table 1 shows the general characteristics of the respondents and the subject schools. There were 608 schools in total with 25 kindergartens (4.1%), 323 elementary schools (53.1%), 136 middle schools (22.4%), and 124 high schools (20.4%). The vast majority of respondents identified as female, representing 98.8% of the total sample. The average age of the participants was 43.4 ± 9.4 years, and the participants from elementary (45.9 ± 7.8 years) and middle schools (43.0 ± 9.5 years) were older than those from kindergartens (37.0 ± 9.0 years) and high schools (38.4 ± 10.4 years; $P < 0.001$). The average total work experience of nutrition teachers and dietitians was 16.0 ± 9.1 years. Among the respondents, 351 were nutrition teachers and 257 were dietitians. Nutrition teachers were present in 57.7% of all the schools (dietitians: 42.3%), with the highest proportion in elementary schools (76.5%) and the lowest in kindergartens (4.0%; $P < 0.001$).

The school locations of respondents were 67.9%, 28.0%, and 4.1%, for urban, rural, and island or remote area, respectively, and there was no significant difference between school levels. Overall, public schools were the most common (84.4%). Most schools operated on-site cooking facilities (89.8%), whereas the proportion of schools utilizing central kitchen cooking was relatively higher among high schools (16.1%; $P = 0.007$). The most common form of eating place was cafeteria

Table 1. General characteristics of the respondents and the subject schools

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Respondents						
Sex						
Male	7 (1.2)	0 (0.0)	5 (1.5)	2 (1.5)	0 (0.0)	0.640
Female	601 (98.8)	25 (100.0)	318 (98.5)	134 (98.5)	124 (100.0)	
Age (year)	43.38 ± 9.35	37.00 ± 8.96 ^a	45.93 ± 7.79 ^b	43.01 ± 9.52 ^b	38.44 ± 10.35 ^a	< 0.001
Years of work experience	15.98 ± 9.05	8.28 ± 6.35 ^a	18.66 ± 8.82 ^d	14.83 ± 8.11 ^c	11.81 ± 8.41 ^b	< 0.001
Job status						
Nutrition teacher	351 (57.7)	1 (4.0)	247 (76.5)	53 (39.0)	50 (40.3)	< 0.001
Dietitian	257 (42.3)	24 (96.0)	76 (23.5)	83 (61.0)	74 (59.7)	
Subject schools						
School locations						
Urban	413 (67.9)	20 (80.0)	203 (62.8)	96 (70.6)	94 (75.8)	0.081
Rural	170 (28.0)	5 (20.0)	105 (32.5)	36 (26.5)	24 (19.4)	
Island or remote area	25 (4.1)	0 (0.0)	15 (4.6)	4 (2.9)	6 (4.8)	
School type						
National	24 (3.9)	0 (0.0)	10 (3.1)	6 (4.4)	8 (6.5)	< 0.001
Public	513 (84.4)	25 (100.0)	312 (96.6)	105 (77.2)	71 (57.3)	
Private	71 (11.7)	0 (0.0)	1 (0.3)	25 (18.4)	45 (36.3)	
Foodservice system						
On-site cooking	546 (89.8)	24 (96.0)	287 (88.9)	131 (96.3)	104 (83.9)	0.007
Central kitchen cooking	62 (10.2)	1 (4.0)	36 (11.1)	5 (3.7)	20 (16.1)	
Eating place						
Cafeteria	530 (87.2)	20 (80.0)	269 (83.3)	122 (89.7)	119 (96.0)	0.003
Classroom	56 (9.2)	4 (16.0)	40 (12.4)	10 (7.4)	2 (1.6)	
Cafeteria + classroom	22 (3.6)	1 (4.0)	14 (4.3)	4 (2.9)	3 (2.4)	
No. of meal participants (lunch)	513.04 ± 404.32	196.24 ± 87.01 ^a	500.79 ± 445.25 ^b	515.95 ± 337.78 ^b	605.64 ± 362.76 ^b	< 0.001
No. of meals/day	1.21 ± 0.57	1.08 ± 0.28 ^a	1.00 ± 0.00 ^a	1.07 ± 0.35 ^a	1.93 ± 0.89 ^b	< 0.001

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, analysis of variance.^{a-d)}Values in the same row with different superscripted letters are significantly different at P < 0.05 using analysis of variance and Duncan's multiple range test.

service in 87.2% of schools, but there were significant differences depending on the school level ($P = 0.003$). At lower school level, there was a higher rate of classroom service. At lunch, the number of people receiving school meals was higher at elementary, middle, and high schools (all ≥ 500 persons) than at kindergartens (196 persons; $P < 0.05$).

2. Status of sodium provision in school meals

Table 2 shows the current status of sodium provision in school meals. An investigation into the establishment of sodium provision standards (mg) per meal for school meals revealed that approximately 26.6% of the sampled schools had not established such standards. Sodium provision standards per menu item had not been established in 30.8% of all schools, and there were no significant differences by school level.

The entire sample of schools (608) had salinometers available. At most schools, the participants reported using the salinometers daily (96.4%), whereas one middle and one high school reported using the salinometers “once per month”. The reasons for not using the salinometer at these schools were “the cooks do not want to do it” and “it is cumbersome to use it” (data not shown in the table).

An investigation into the management of portion sizes for school meals revealed that 66.3% of schools provided different portions depending on the school grade and sex of students. There were also significant differences by school level ($P < 0.001$). High proportions of kindergartens (72.0%) and elementary schools (94.4%) provided different portions by school grade and student sex, whereas high proportions of middle (68.4%) and high schools (70.2%) provided identical portions to all students.

3. Status of sodium reduction management and education for school meals

Table 3 shows the current status of sodium reduction management in school meals. When asked if they had held special events to encourage sodium reduction in the past year, 47.5% said they had, with no differences by school level. The events mostly consisted of “No Soup Days” and “Low-Sodium Days” (data not displayed in the table). At more than half of the schools (59.9%), par-

ticipants reported that they had never used low-sodium products in school meals, and there were significant differences by school level ($P = 0.001$). The proportion of participants who did not use low-sodium products was higher at higher school levels (kindergartens 48.0%, elementary schools 53.6%, middle schools 66.9%, high schools 71.0%).

At the 364 schools that had never used low-sodium products, the most common reasons for not using low-sodium products were “insufficient information” (46.7%) and “high prices” (41.5%). There were significant differences by school level; high prices were of a greater concern in middle and high schools than in other schools ($P < 0.001$), while insufficient information was a very common reason in kindergartens (91.7%; $P = 0.012$). The most common reason was “difficult to purchase” in elementary schools (22.0%; $P < 0.001$).

Most schools (90.5%) reported using a salinometer to measure the salinity of soups and stews. As a result of comparing how much sodium content or provision was considered at each stage of school meal preparation using scores (1–5 points), the response “sodium content is considered when cooking (e.g., adjusting the amount of seasoning using salt, fermented sauces, and soy sauce)” showed the highest average score (3.89 points), while the response “sodium content is considered when purchasing ingredients (e.g., low-sodium soy sauce)” showed the lowest average score (3.20 points). There were differences between school levels at all stages of food preparation. The level of consideration when planning the menu was significantly higher in elementary (3.78 points) than in middle (3.46 points) or high schools (3.45 points; $P < 0.05$). The level of consideration while purchasing ingredients was significantly higher in elementary (3.35 points) than in middle schools (2.96 points; $P < 0.05$). The level of consideration when cooking was significantly higher in kindergartens (4.16 points) and elementary schools (4.03 points) than in middle (3.74 points) and high schools (3.64 points; $P < 0.05$).

Table 4 shows the status of sodium reduction education by school level. Among the nutrition teachers and dietitians who responded to the survey, 38.5% had completed sodium reduction education, and there were no differences by school level. A total of 33.9% of the partic-

Table 2. Current status of sodium provision in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Establishment of sodium provision standards						
Yes	446 (73.4)	16 (64.0)	234 (72.4)	98 (72.1)	98 (79.0)	0.334
No	162 (26.6)	9 (36.0)	89 (27.6)	38 (27.9)	26 (21.0)	
Sodium provision standards per menu item						
Yes	421 (69.2)	15 (60.0)	226 (70.0)	85 (62.5)	95 (76.6)	0.067
No	187 (30.8)	10 (40.0)	97 (30.0)	51 (37.5)	29 (23.4)	
Possession of a salinometer	608 (100.0)	25 (100.0)	323 (100.0)	136 (100.0)	124 (100.0)	
Frequency of using a salinometer						
Once a month	2 (0.3)	0 (0.0)	0 (0.0)	1 (0.7)	1 (0.8)	0.139
1–2 times a week	12 (2.0)	1 (4.0)	4 (1.2)	4 (2.9)	3 (2.4)	
3–4 times a week	8 (1.3)	0 (0.0)	2 (0.6)	2 (1.5)	4 (3.2)	
Everyday	586 (96.4)	24 (96.0)	317 (98.1)	129 (94.9)	116 (93.5)	
Establishment of standard meal portion sizes per person						
Yes	458 (75.3)	18 (72.0)	233 (72.1)	109 (80.1)	98 (79.0)	0.209
No	150 (24.7)	7 (28.0)	90 (27.9)	27 (19.9)	26 (21.0)	
Meal portion sizes						
The same for all students	205 (33.7)	7 (28.0)	18 (5.6)	93 (68.4)	87 (70.2)	< 0.001
Different portions depending on the school grade and sex	403 (66.3)	18 (72.0)	305 (94.4)	43 (31.6)	37 (29.8)	

n (%).

¹⁾P-value by chi-squared test or Fisher's exact test.**Table 3.** Current status of sodium reduction management in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Sodium reduction events						
Yes	289 (47.5)	8 (32.0)	151 (46.7)	68 (50.0)	62 (50.0)	0.372
No	319 (52.5)	17 (68.0)	172 (53.3)	68 (50.0)	62 (50.0)	
Use of low-sodium products						
Yes	244 (40.1)	13 (52.0)	150 (46.4)	45 (33.1)	36 (29.0)	0.001
No	364 (59.9)	12 (48.0)	173 (53.6)	91 (66.9)	88 (71.0)	

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Table 3. Continued

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Reasons for not using low-sodium products ²⁾						
Insufficient information	170 (46.7)	11 (91.7)	81 (46.8)	42 (46.2)	36 (40.9)	0.012
High prices	151 (41.5)	5 (41.7)	51 (29.5)	47 (51.6)	48 (54.5)	< 0.001
Limited product variety	97 (26.6)	2 (16.7)	50 (28.9)	28 (30.8)	17 (19.3)	0.234
Poor taste	93 (25.5)	2 (16.7)	43 (24.9)	21 (23.1)	27 (30.7)	0.562
Difficult to purchase	52 (14.3)	1 (8.3)	38 (22.0)	10 (11.0)	3 (3.4)	< 0.001
Other	15 (4.1)	0 (0.0)	10 (5.8)	3 (3.3)	2 (2.3)	0.601
Methods for measuring salinity						
Using a salinometer	550 (90.5)	24 (96.0)	298 (92.3)	120 (88.2)	108 (87.1)	0.206
Sensory evaluation by food service staff	13 (2.1)	0 (0.0)	6 (1.9)	3 (2.2)	4 (3.2)	
Sensory evaluation by nutrition teacher/dietitian	27 (4.4)	0 (0.0)	8 (2.5)	9 (6.6)	10 (8.1)	
Other	18 (3.0)	1 (4.0)	11 (3.4)	4 (2.9)	2 (1.6)	
Level of sodium management at each stage of school meal preparation ³⁾						
Menu planning	3.64 ± 0.80	3.72 ± 0.74 ^{ab}	3.78 ± 0.76 ^b	3.46 ± 0.78 ^a	3.45 ± 0.87 ^a	< 0.001
Purchasing ingredients	3.20 ± 0.93	3.24 ± 0.97 ^{ab}	3.35 ± 0.93 ^b	2.96 ± 0.88 ^a	3.06 ± 0.93 ^{ab}	< 0.001
Cooking	3.89 ± 0.77	4.16 ± 0.69 ^b	4.03 ± 0.73 ^b	3.74 ± 0.71 ^a	3.64 ± 0.87 ^a	< 0.001
Serving	3.65 ± 0.87	3.60 ± 1.04	3.77 ± 0.84	3.50 ± 0.87	3.54 ± 0.89	0.007

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, or analysis of variance.

²⁾Multiple responses.

³⁾5-point Likert scale (1: not at all considered–5: highly considered).

^{ab}Values in the same row with different superscripted letters are significantly different at *P* < 0.05 using analysis of variance and Duncan's multiple range test.

Table 4. Status of sodium reduction education by school level

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Participation of nutrition teachers/dietitians in sodium reduction education						
Yes	234 (38.5)	8 (32.0)	123 (38.1)	55 (40.4)	48 (38.7)	0.876
No	374 (61.5)	17 (68.0)	200 (61.9)	81 (59.6)	76 (61.3)	
Provision of sodium reduction education for students						
Yes	402 (66.1)	10 (40.0)	228 (70.6)	87 (64.0)	77 (62.1)	0.009
No	206 (33.9)	15 (60.0)	95 (29.4)	49 (36.0)	47 (37.9)	

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Table 4. Continued

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Methods of education ²⁾						
Newsletter for parents	297 (73.9)	7 (70.0)	180 (78.9)	59 (67.8)	51 (66.2)	0.066
School websites for parents	275 (68.4)	7 (70.0)	142 (62.3)	67 (77.0)	59 (76.6)	0.023
Education for cooks	232 (57.7)	7 (70.0)	128 (56.1)	49 (56.3)	48 (62.3)	0.668
Displaying posters in the cafeteria for students	111 (27.6)	2 (20.0)	63 (27.6)	27 (31.0)	19 (24.7)	0.776
Education during regular class time for students	94 (23.4)	0 (0.0)	91 (39.9)	1 (1.1)	2 (2.6)	< 0.001
Education for school teacher	51 (12.7)	2 (20.0)	30 (13.2)	9 (10.3)	10 (13.0)	0.811
Special extracurricular activities for students	17 (4.2)	0 (0.0)	9 (3.9)	1 (1.1)	7 (9.1)	0.078

n (%).

¹⁾P-value by chi-squared test or Fisher's exact test.²⁾Multiple responses.

ipants reported that they had not provided sodium reduction education to students in the last year, and there were differences by school level ($P = 0.009$). The proportion of participants not providing education was especially high in kindergartens (60.0%). Overall, the most commonly used type of education for sodium reduction was newsletter to parents (73.9%), and other methods included school websites (68.4%) and education for cooks (57.7%). The method of educating students using regular class time was observed almost exclusively in elementary schools (39.9%; $P < 0.001$).

4. Sodium-related awareness and support requirements

Regarding the perceived saltiness of school meals, the most common response from nutrition teachers and dietitians was “normal” (78.9%) (Table 5). The saltiness of school meals was perceived to be milder at lower school levels compared with higher school levels ($P < 0.001$). In only 8.9% of schools, participants reported knowing the sodium levels of all menu items provided for school meals, whereas in 18.6%, participants responded they were completely unaware.

The average overall score for interest in sodium reduction was 3.82/5 points, and there were significant differences by school level ($P = 0.001$). Interest was significantly higher in kindergartens (4.00 points) than in middle (3.75 points) or high schools (3.72 points; $P < 0.05$). As for the difficulties in practicing sodium reduction, the average score was 2.31 points. There were significant differences depending on school level ($P < 0.001$), with participants at the kindergarten (2.56 points) and elementary school levels (2.45 points) showing higher scores for difficulty in reducing sodium intake than those at the middle school (2.18 points) and high school levels (2.05 points; $P < 0.05$).

To reduce sodium in school meals, the most commonly reported requirement was “reduction of the excessive foodservice workload” (4.48 points), followed by “support for educational materials” (4.31 points) and “sodium reduction education for students” (4.22 points). There were no differences in any items by school level.

DISCUSSION

Because the level of sodium intake from school meals

Table 5. Awareness and support requirements related to sodium in school meals

Characteristics	Total (n = 608)	School level				P-value ¹⁾
		Kindergarten (n = 25)	Elementary school (n = 323)	Middle school (n = 136)	High school (n = 124)	
Perceived saltiness level of school meals by nutrition teachers/dietitians						
Not salty at all	1 (0.2)	0 (0.0)	0 (0.0)	1 (0.7)	0 (0.0)	< 0.001
Not salty	120 (19.7)	12 (48.0)	82 (25.4)	14 (10.3)	12 (9.7)	
Normal	480 (78.9)	13 (52.0)	237 (73.4)	120 (88.2)	110 (88.7)	
Salty	7 (1.2)	0 (0.0)	4 (1.2)	1 (0.7)	2 (1.6)	
Awareness of amount of sodium in each menu item						
All menus	54 (8.9)	0 (0.0)	28 (8.7)	16 (11.8)	10 (8.1)	0.538
Some menus	441 (72.5)	18 (72.0)	237 (73.4)	95 (69.9)	91 (73.4)	
Completely unaware	113 (18.6)	7 (28.0)	58 (18.0)	25 (18.4)	23 (18.5)	
Perception related to sodium reduction						
Interest in sodium reduction ²⁾	3.82 ± 0.63	4.00 ± 0.58 ^b	3.93 ± 0.60 ^{ab}	3.75 ± 0.63 ^a	3.72 ± 0.68 ^a	0.001
Necessity of reducing sodium ³⁾	3.51 ± 0.73	3.40 ± 0.65	3.48 ± 0.79	3.53 ± 0.69	3.62 ± 0.66	0.250
Difficulty in practicing sodium reduction ⁴⁾	2.31 ± 0.72	2.56 ± 0.82 ^b	2.45 ± 0.72 ^b	2.18 ± 0.61 ^a	2.05 ± 0.73 ^a	< 0.001
Reasons for difficulty in reducing sodium ⁵⁾						
Decrease in satisfaction of students	331 (86.6)	9 (90.0)	156 (87.6)	86 (84.3)	80 (87.0)	0.860
Due to poor taste	183 (47.9)	5 (50.0)	88 (49.4)	46 (45.1)	44 (47.8)	0.922
Lack of budget for purchasing low-sodium products	79 (20.7)	2 (20.0)	37 (20.8)	22 (21.6)	18 (19.6)	0.979
Lack of information on sodium reduction	52 (13.6)	1 (10.0)	28 (15.7)	14 (13.7)	9 (9.8)	0.611
Staff unwilling to implement	27 (7.1)	2 (20.0)	15 (8.4)	4 (3.9)	6 (6.5)	0.191
Support requirements related to sodium management						
Reduction of the excessive foodservice workload	4.48 ± 0.70	4.40 ± 0.82	4.51 ± 0.67	4.39 ± 0.73	4.51 ± 0.74	0.354
Support for educational materials	4.31 ± 0.72	4.16 ± 0.80	4.34 ± 0.69	4.26 ± 0.76	4.31 ± 0.71	0.504
Sodium reduction education for students	4.22 ± 0.69	4.16 ± 0.85	4.26 ± 0.66	4.13 ± 0.73	4.23 ± 0.70	0.263
Sodium reduction education for foodservice staff	4.17 ± 0.72	4.12 ± 0.78	4.23 ± 0.71	4.04 ± 0.73	4.15 ± 0.71	0.098
Sodium reduction education for parents	4.15 ± 0.72	4.16 ± 0.75	4.21 ± 0.69	4.07 ± 0.75	4.10 ± 0.74	0.232
Sodium reduction education for teachers	4.10 ± 0.75	4.04 ± 0.98	4.12 ± 0.74	4.07 ± 0.77	4.08 ± 0.73	0.867
Supply of low-sodium recipes	4.06 ± 0.81	4.08 ± 0.86	4.15 ± 0.77	3.93 ± 0.88	3.99 ± 0.79	0.050
Sodium reduction education for dietitians	4.01 ± 0.73	3.92 ± 0.86	4.05 ± 0.72	3.96 ± 0.71	3.96 ± 0.74	0.453

n (%) or Mean ± SD.

¹⁾P-value by chi-squared test, Fisher's exact test, or analysis of variance.²⁾5-point Likert scale (1: not at all interested - 5: very interested).³⁾5-point Likert scale (1: not at all necessary - 5: very necessary).⁴⁾5-point Likert scale (1: not at all difficult - 5: very difficult).⁵⁾Multiple responses.^{ab}Values in the same row with different superscripted letters are significantly different at $P < 0.05$ using analysis of variance and Duncan's multiple range test.

can affect the health of students in kindergartens and elementary, middle, and high schools, it is important to manage sodium provision in school meals. However, in this study, 26.6% of the sampled nutrition teachers and dietitians reported that they had not established sodium provision standards for school meals. Sodium standards are a tool to help appropriately manage sodium provision when planning and cooking school meals. In South Korea, the nutritional standards for school meals are managed by the government according to the Enforcement Decree of the School Meals Act, and sodium standards are not included in the nutritional standards for school meal [31]. The Ministry of Education proposed target sodium level per meal and recommended each school to independently set and manage sodium standards [17].

Several countries including the US, Japan, and the United Kingdom, have established sodium standards in their nutritional standards for school meals. In the US, until July, 2027, sodium provision levels for school lunches must be < 935, < 1,035, and < 1,080 mg for grades K-5, 6-8, and 9-12, respectively [32], and in Japan, the sodium provision levels for school lunches are < 600, < 800, < 800, and < 1,000 mg for students aged 6-7 years, 8-9 years, 10-11 years, and 12-14 years, respectively [33]. In the United Kingdom, to limit sodium provision, it is forbidden to provide salt to add to food after it has been cooked, or to use high-sodium flavor enhancers such as MSG or E621 [34]. Detailed criteria have also been established for checking labeled salt levels; using herbs, spices, garlic, vegetables and fruits to add flavor to dishes instead of salt; and choosing biscuits, cakes and pastries that are lower in fat, saturated fat, sugar and salt. There is a need to incorporate sodium standards into the nutritional standards for school meals in South Korea as well.

More than half of the participants who responded to the questionnaire in this study reported that they had not used low-sodium products in school meals, and the most common reasons for not using these products were “insufficient information” and “high prices”. Lee [23] reported that 90.5% of nutrition teachers and dietitians had not used low-sodium products. Although direct comparison is limited, the findings may cautiously suggest a potential increase in the use of low-sodium

products over the past decade. Additionally, the same study reported that the most common reasons for not using low-sodium products were “insufficient information,” “high prices,” and “lack of product diversity,” which were similar to the reasons reported in this study. In the US, the major strategies for sodium reduction include the development of low-sodium products [35]. Using low-sodium products can be considered a starting point for sodium provision management. Therefore, it is imperative to provide nutrition teachers and dietitians with the necessary information and education to ensure their awareness of the need to use low-sodium products. In particular, information provision and education should be prioritized for nutrition teachers and dietitians in middle or high schools that showed a higher incidence of not using low-sodium products in this study. Food companies also need to develop diverse low-sodium products with policy support from the government, and low-sodium products need to be popularized through proper price-setting and active publicity.

The level of consideration for sodium management at each stage of school meal preparation was highest at the “cooking,” followed by the “serving,” “menu planning,” and “ingredient purchasing.” In a study investigating the status of salt reduction in the Jeju region [36], 98.7% of nutrition teachers and dietitians reported making efforts to reduce sodium at the cooking stage among the school meal preparation stages, 86.4% at the menu planning stage, and 68.8% at the ingredient purchasing stage, which is similar to the findings of this study. In this study, the level of consideration for sodium provision was between “neutral” (3.0 points) and “considered” (4.0 points) at all stages. Management should be provided at a level of “considered” (4.0 points) or above for all stages. Thus, it will be necessary to develop sodium reduction management guidelines for each stage of school meal preparation, while also providing education to help nutrition teachers and dietitians implement these guidelines.

In this study, only 38.5% of all nutrition teachers and dietitians reported having completed an educational course on sodium reduction. Jeong [36] reported that 97.4% of nutrition teachers and dietitians perceived a need for sodium reduction education for nutrition teachers and dietitians, and 76.4% reported that sodium

reduction education and training would help reduce sodium in school meals. In Kim's study [37], 79.1% of nutrition teachers perceived sodium reduction education as necessary for nutrition teachers and dietitians. Taken together, these findings illustrate that there is an urgent need to develop a sodium reduction curriculum for nutrition teachers and dietitians at the government level to manage sodium provision in school meals. Additionally, 33.9% of the participants in this study reported that they had provided no sodium reduction education in school over the past year, and this proportion was highest in kindergartens. For nutrition teachers and dietitians to provide sodium reduction education, it will be necessary to develop and support specific educational materials depending on the recipients of the education (cooks, students, teachers, and parents) and the school level of the students (kindergarten and elementary, middle, and high school).

To reduce sodium levels in school meals, the most strongly reported requirement was "reduction of the excessive foodservice workload," followed by "support for educational materials." These findings suggest that the workload of nutrition teachers and dietitians may be associated with challenges in allocating sufficient time for sodium reduction management. Additionally, support for educational materials was identified as an important need that could facilitate more efficient sodium reduction practices. Overall, addressing these perceived barriers may help improve the implementation of sodium reduction strategies in school foodservice settings.

Overall, this study found significant differences in sodium-related management, education, and perceptions by the school level, suggesting that sodium reduction strategies in school meals should be tailored to the specific operational contexts of each school level. Taken together, these findings emphasize the importance of developing differentiated strategies for sodium reduction in school meals, including strengthening informational and educational support in kindergartens, enhancing practical feasibility in middle and high schools, and sustaining effective management practices in elementary schools. Another important consideration is that sodium-reduction practices may be weaker in kindergartens and middle and high schools, where the use of low-sodium products or educational activities was less

common.

The findings of this study suggest the need for national-level action to strengthen sodium-reduction management in South Korean school meals. More comprehensive and consistently implemented policy approaches may be needed to support sodium reduction in school meals. Policymakers may consider incorporating clear sodium standards into the nutritional standards for school meals to promote more consistent management across all schools. Expanding the availability of diverse and affordable low-sodium products through government-industry collaboration could also be beneficial. Reducing the excessive workload of nutrition teachers and dietitians may help facilitate the implementation of sodium-reduction practices. Moreover, developing standardized, stage-specific guidelines for sodium management—covering ingredient purchasing, menu planning, cooking, and serving—could contribute to more systematic sodium management in schools.

One strength of this study is that the survey was conducted in kindergartens and elementary, middle, and high schools nationwide. Therefore, the findings of this study can be used as a baseline to devise specific and practical methods for reducing sodium in school meals. Future studies should include qualitative investigations to more deeply explore the barriers and facilitators to implementing sodium-reduction policies in school meals. Furthermore, research that objectively measures the actual sodium content of school meals, along with studies evaluating low-sodium product adoption and targeted education programs, will be essential for identifying practical strategies that can support sustainable sodium reduction in school meal settings.

Limitations

This study has several limitations. Although analyses were conducted by school level, the observed differences may have been influenced by other school-related characteristics (e.g., job status, school type, foodservice system, and number of meal participants), which could act as potential confounders. Therefore, further research employing more comprehensive analytical approaches is needed.

Moreover, kindergartens have been included in the school meal service since 2021, and currently only pub-

lic kindergartens use the NEIS. Among the study participants, kindergartens were limited to public institutions that use NEIS and provide school meals, and therefore the findings should be interpreted with caution.

In addition, this study relied on self-reported data from nutrition teachers and dietitians, which may be subject to recall bias or social desirability bias. The survey was conducted within a limited period (September to November 2021), and sodium-reduction practices may have changed since then due to policy revisions or market developments related to low-sodium products.

Conclusion

There appears to be a need to strengthen sodium-reduction management in South Korean school meals. To support sodium reduction, it may be helpful to consider establishing clearer sodium standards within the nutritional standards for school meals, developing and promoting low-sodium products, reducing excessive workload, and enhancing educational support. These findings highlight potential areas for policy and practice improvement.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

The data that support the findings of this study are available from Korea Educational Environments Protection Agency. Restrictions apply to the availability of these data, which were used under license for this study.

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Research Article

Changing patterns and related factors of *kimchi* consumption among Korean adults: a nationwide cross-sectional analysis of the Korea National Health and Nutrition Examination Survey, 2010–2024

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Objectives: This study was conducted to analyze long-term trends in *kimchi* consumption and patterns among Korean adults using data from the Korea National Health and Nutrition Examination Survey (KNHANES) from 2010 to 2024, and to identify sociodemographic, dietary, and health-related factors associated with recent *kimchi* consumption.

Methods: Data from the 5th (2010) through 9th (2024) KNHANES were utilized. Trend analysis included 103,267 participants, while factor analysis focused on 14,244 adults aged ≥ 30 years (2022–2024). Changes in consumption form (side dish versus ingredient) and locations were examined. Multiple logistic regression was used to calculate odds ratios (ORs) for meeting the recommended intake (40 g/day).

Results: Over the past 15 years, *kimchi* consumption among Korean adults has significantly decreased regardless of gender (men: $\beta = -1.53$, women: $\beta = -1.31$, P for trend < 0.05). The proportion of individuals reporting no *kimchi* intake on the 24-hour recall day increased from 11.7% in 2010 to 22.7% in 2024. Among young adults (20–39 years), a qualitative shift occurred as consumption transitioned from side dishes to dish ingredients. At-home consumption decreased for all age groups under 60 years. Conversely, eating-out consumption increased for most groups, except for those aged 20–39 years, while school/workplace consumption increased only in the 0–9 years age group. Analysis of the factors associated with meeting the recommended intake revealed that men, older adults, rural residents, married individuals, alcohol consumers, and smokers were more likely to meet the recommendation. Conversely, frequent solo dining or skipping meals were significantly associated with a lower likelihood of meeting the recommendation.

Conclusion: This study confirms a structural shift in the Korean diet. Future strategies for preserving traditional food culture and establishing nutritional policies must be tailored to reflect modern dietary changes, such as an increase in single-person households and the spread of a solo-dining culture.

Keywords: *kimchi*; trends; factor analysis, statistical; feeding behavior; nutrition surveys

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INTRODUCTION

Kimchi is a fermented food that epitomizes Korean traditional food culture; its communal preparation practice, *kimjang*, has been inscribed on the United Nations Educational, Scientific and Cultural Organization Representative List of the Intangible Cultural Heritage of Humanity [1]. The nutritional and public health significance of *kimchi* has also gained broad international recognition following its official recommendation as a beneficial fermented food in the Dietary Guidelines for Americans 2025–2030, jointly issued by the U.S. Department of Health and Human Services (HHS) and the United States Department of Agriculture (USDA) [2]. *Kimchi* is prepared primarily from napa cabbage and radish, supplemented with red pepper powder, garlic, ginger, and salted fermented seafood, among other ingredients. The fermentation process generates lactic acid bacteria, and the constituent raw materials contribute dietary fiber, vitamins, and phytochemicals; these bioactive components have been associated with diverse health-promoting effects, including anti-obesity [3], anti-cancer [4], and immune-enhancing properties [5, 6].

However, rapid social structural changes and the progressive Westernization of dietary habits have resulted in marked differences in both the proportion of *kimchi* consumed within the Korean diet and the overall consumption patterns compared with those of the preceding decades [7]. The rapid increase in single-person households [8], widespread adoption of a solo-dining culture [9], normalization of home meal replacement (HMR) products [10], and continued expansion of the food service industry [11] are the principal drivers of structural change in both the contexts and modes by which *kimchi*, a cornerstone of the traditional Korean table, is consumed. A general declining trend in *kimchi* consumption has been reported among Koreans [12, 13]; however, most investigations have been limited to cross-sectional analyses at single time points or historical datasets. Comprehensive long-term trend analyses that incorporate recent sociodemographic and dietary changes, including detailed assessments of consumption patterns, remain limited.

Changes in *kimchi* consumption extend beyond a

simple reduction in intake quantity and encompass qualitative shifts in who consumes *kimchi*, where it is consumed, and in what form, thereby necessitating a more comprehensive analytical approach. Whereas *kimchi* was traditionally consumed as a side dish (*ban-chan*) in home-based meals, an increasing proportion is now incorporated as an ingredient in prepared dishes in restaurants or in processed foods. These shifts are closely related to broader dietary pattern changes among Korean adults [14] and have been identified as significant contributors to chronic disease risk [15]. Accordingly, stratified analyses of the associations between socioeconomic status, health behaviors, dietary characteristics, and *kimchi* intake adherence by gender and age group can provide a critical evidence base for identifying populations at high risk for chronic diseases and formulating precise nutrition-oriented individualized nutritional policies [16].

Therefore, the present study aimed to analyze long-term population-level trends in *kimchi* consumption among Korean adults using Korea National Health and Nutrition Examination Survey (KNHANES) data from the 5th survey cycle (2010–2012) to the 9th survey cycle (2022–2024). Specifically, this study examined secular changes in *kimchi* intake by gender and age group, as well as shifts in consumption patterns by intake form (*kimchi* as a side dish vs. *kimchi* as an ingredient in composite dishes) and meal location. Furthermore, using the most recent 3-year data (2022–2024), a multifaceted analysis was conducted to characterize the sociodemographic, dietary, and health behavior factors associated with *kimchi* consumption, with the aim of elucidating the public health significance of *kimchi* intake and its policy implications within the context of contemporary dietary change among Korean adults.

METHODS

Ethics statement

The study protocol was approved by the Institutional Review Board (IRB) of the Korea Disease Control and Prevention Agency (KDCA) (Approval Nos. 2010-02CON-21-C, 2011-02CON-06-C, 2012-01EXP-01-2C, 2013-07CON-03-4C, 2013-12EXP-03-5C, 2018-01-03-P-A, 2018-01-03-C-A, 2018-01-03-2C-A, 2018-01-03-5C-A, 2018-01-03-4C-A, 2022-11-16-R-A, and 2022-11-16-R-03). Informed written consent was obtained from all participants.

1. Study design

This cross-sectional study was conducted in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines (<https://www.strobe-statement.org/>).

2. Study population and data collection

To analyze secular trends in *kimchi* consumption, consumption forms, and meal location patterns among Korean adults, this study utilized KNHANES data from the 5th survey cycle (2010–2012) through the 9th survey cycle (2022–2024). The KNHANES is a nationally representative repeated cross-sectional survey based on stratified, multistage probability cluster sampling. In addition to population-level long-term trend analyses, factor analyses of variables associated with *kimchi* consumption were conducted using data from the most recent 3-year period (2022–2024), applying survey-weighted logistic regression models incorporating sociodemographic and dietary characteristics, with 40 g/day (the recommended single serving of *kimchi*) as the reference threshold.

For the trend analysis, 103,267 participants (45,706 men and 57,561 women) were included after excluding 12,234 individuals, who lacked survey weight data, from the initial 115,501 eligible respondents. Of these, 86,090 reported *kimchi* consumption on the 24-hour dietary recall day, whereas 17,177 reported no consumption. Trend analyses were conducted separately for the total study population and *kimchi* intake subgroups. Long-term changes in *kimchi* intake and the proportion of non-consumers were estimated in the *kimchi* consumer subgroup; detailed consumption patterns by form and

meal location were additionally examined.

The factor analysis was restricted to adults aged ≥ 30 years, as prior research indicates that socioeconomic indicators and lifestyle factors are relatively well established in this age group [17]. Among the 20,191 KNHANES participants surveyed between 2022 and 2024, those aged < 30 years ($n = 4,864$), those lacking survey weight data or who did not participating in the 24-hour dietary recall ($n = 590$), and those with physiologically implausible energy intake (women: < 500 kcal/day or $> 3,500$ kcal/day; men: < 800 kcal/day or $> 4,000$ kcal/day; $n = 493$) were excluded. The final analytic sample comprised 14,244 participants, stratified by age group (30–64 years: $n = 9,138$; ≥ 65 years: $n = 5,106$) and gender (men: $n = 6,003$; women: $n = 8,241$).

3. Measurements and variable definitions

1) Assessment and classification of kimchi consumption

Kimchi intake was estimated using the primary food code (N_FCODE), dish name, and intake quantity variables obtained from the 24-hour dietary recall. Based on prior research [18], *kimchi* types were classified as *baechu kimchi* (napa cabbage *kimchi*), *kkakdugi kimchi* (cubed radish *kimchi*), *yeolmu kimchi* (young radish *kimchi*), *nabak kimchi* (watery radish and cabbage *kimchi*), and other *kimchi* (including *oi sobagi*, *yuche kimchi*, and *eolgari baechu kimchi*). Given the nature of the 24-hour dietary recall method, participants with zero *kimchi* intake were defined as non-consumers on the day of the dietary recall, rather than as habitual abstainers.

Kimchi consumption form was classified by first extracting all records containing *kimchi* ingredients based on the food code (N_FCODE) and then applying the corresponding dish code (N_DCODE) to differentiate the intake form. Cases in which the dish name explicitly denoted a side dish (e.g., *baechu kimchi*, *kkakdugi* consumed as standalone accompaniments) were defined as '*kimchi* as a side dish.' Cases involving composite dishes, such as *kimchi-jjigae* (*kimchi* stew) or *kimchi-jeon* (*kimchi* pancake), were defined as '*kimchi* in a dish', with the net weight of *kimchi* ingredients (NF_INTK) extracted and summed accordingly.

Meal location was categorized into three settings:

home, school/workplace (encompassing schools, workplaces, senior centers, and religious institution cafeterias), and restaurant (commercial food service establishments). Responses coded as 'other' or 'unknown/no response' were excluded.

Kimchi intake level was classified based on the single-serving recommended intake of 40 g/day as specified in the Dietary Reference Intakes for Koreans [19]. This threshold has also been applied in previous domestic epidemiological studies [20, 21], and was adopted in the present study to ensure comparability across studies. Participants were classified as meeting (≥ 40 g/day) or not meeting (< 40 g/day) the recommended intake.

2) Definition of general characteristics

Sociodemographic characteristics included gender, body mass index (BMI; kg/m^2), educational attainment, household income level, smoking status, alcohol consumption, physical activity level, residential area, marital status, and household size. BMI was classified into four categories per Korean Society for the Study of Obesity criteria [22]: underweight ($\text{BMI} < 18.5 \text{ kg}/\text{m}^2$), normal weight ($18.5 \leq \text{BMI} < 23 \text{ kg}/\text{m}^2$), overweight ($23 \leq \text{BMI} < 25 \text{ kg}/\text{m}^2$), and obese ($\text{BMI} \geq 25 \text{ kg}/\text{m}^2$). Educational attainment was classified as middle school graduate or lower, high school graduate, or college graduate or above. Household income was estimated as monthly equivalized household income (monthly household income divided by the square root of household size) and categorized into quartiles: low, middle-low, middle-high, and high.

Smoking status was classified as never smoker (no smoking history), past smoker (prior smoking history, not currently smoking), or current smoker (smoking daily or occasionally at the time of the survey). Alcohol consumption was dichotomized ('yes'/'no') based on whether the respondent reported consuming alcohol at least once per month over the preceding year. Physical activity was classified as 'active' or 'inactive' according to the KNHANES user guidelines [22], with 'active' defined as ≥ 75 min/week of vigorous-intensity activity, ≥ 150 min/week of moderate-intensity activity, or an equivalent combination thereof. Residential area was categorized as 'urban' (*dong* administrative district) or 'rural' (*eup/myeon* administrative district). Marital

status was classified as 'married' (currently cohabiting with a spouse) or 'single' (encompassing never-married, separated, widowed, and divorced).

Dietary characteristics included meal environment and behavioral variables. Frequency of eating with others was classified as 'none', 'once per day', or ' $\geq$ twice per day', based on whether the respondent shared meals with family members or others over the preceding year. Eating-out frequency was categorized as ' ≥ 1 day', '1–6 times/week', '1–3 times/month', or 'scarcely'. Meal frequency was assessed based on meal consumption during the 2 days preceding the dietary intake survey and classified as '3 meals/day' or '1–2 meals/day'.

4. Statistical analysis

As the KNHANES is based on a complex, stratified, multistage probability cluster sampling design, all analyses incorporate stratification variables, cluster variables, and individual sampling weights.

Trend analyses of *kimchi* intake and the proportion of non-consumers were conducted using the KNHANES data from 2010 to 2024, stratified by gender. Annual changes in *kimchi* intake were assessed using survey-weighted linear regression (PROC SURVEYREG), with survey year treated as a continuous variable; regression coefficients (β) and corresponding *P*-values were used to evaluate linear trends.

For the factor analysis using 2022–2024 data, survey-weighted logistic regression (PROC SURVEYLOGISTIC) was performed, with meeting the recommended *kimchi* intake (≥ 40 g/day) as the dependent variable. Results were presented as odds ratios (ORs) and 95% confidence intervals (CIs) from (i) a base model adjusted for age (continuous), gender, total energy intake, and total food intake; and (ii) a multivariable model additionally adjusted for educational attainment, household income, residential area, household composition, smoking status, alcohol consumption, and physical activity.

All statistical analyses were performed using SAS (Statistical Analysis System, version 9.4; SAS Institute). Statistical significance was set at $P < 0.05$.

RESULTS

1. Trends in kimchi consumption among Korean adults
Analysis of KNHANES data from 2010 to 2024 revealed a significant and broadly consistent decline in consumption of most kimchi types (Fig. 1). The most pronounced declining trend was observed for *baechu kimchi*, the

predominant kimchi variety, relative to the other kimchi types.

In gender-stratified analyses, significant declining trends (P for trend < 0.001) were observed among men for all kimchi types except other kimchi, with the greatest decreases for total kimchi ($\beta = -1.532$) and *baechu kimchi* ($\beta = -1.018$). Among women, significant de-

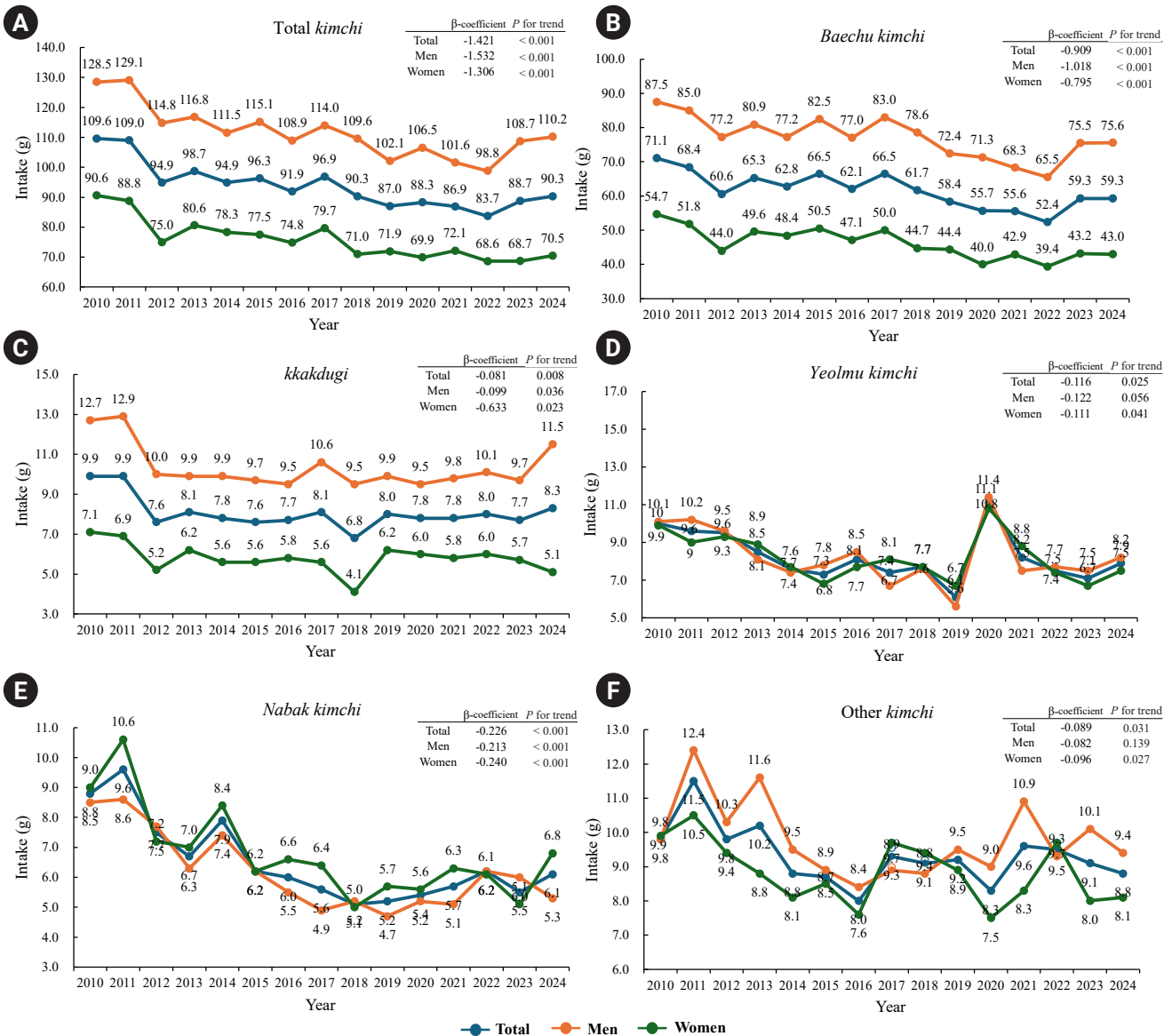


Fig. 1. Trends in kimchi consumption by gender among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of (A) total kimchi, (B) *baechu kimchi*, (C) *kkakdugi*, (D) *yeolmu kimchi*, (E) *nabak kimchi*, and (F) other kimchi. Values are presented as survey-weighted means. Blue lines indicate the total population, orange lines indicate men, and green lines indicate women. β -coefficients represent annual changes in intake estimated using survey-weighted linear regression (PROC SURVEYREG); P for trend values were obtained from the same models.

clining trends were observed across all *kimchi* types (P for trend < 0.001); total *kimchi* ($\beta = -1.306$) showed the greatest absolute decline, with *baechu kimchi* ($\beta = -0.795$) exhibiting a particularly pronounced downward trajectory. A transient increase in *yeolmu kimchi* consumption was observed between 2019 and 2020. However, the long-term trajectory remained consistent with an overall declining trend.

Among *kimchi* consumers (i.e., those reporting intake on the recall day), a significant overall declining trend was observed (Fig. 2). Total *kimchi* intake in this subgroup showed a statistically significant decrease ($\beta = -0.623$, $P < 0.001$), with similar patterns in men ($\beta = -0.641$, $P < 0.001$) and women ($\beta = -0.632$, $P < 0.001$). *Baechu kimchi* demonstrated a significant decline ($\beta = -0.378$, $P < 0.001$), consistent in women ($\beta = -0.384$) and



Fig. 2. Trends in *kimchi* consumption by gender among participants in the *kimchi* intake group, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of (A) total *kimchi*, (B) *baechu kimchi*, (C) *kkakdugi*, (D) *yeolmu kimchi*, (E) *nabak kimchi*, and (F) other *kimchi*. Values are presented as survey-weighted means. Blue lines indicate the total population, orange lines indicate men, and green lines indicate women. β -coefficients represent annual changes in intake estimated using survey-weighted linear regression (PROC SURVEYREG); P for trend values were obtained from the same models.

men ($\beta = -0.395$). *Nabak kimchi* also showed a statistically significant decreasing trend in the *kimchi* consumer subgroup for both genders. Annual changes in *kka-kdugi*, *yeolmu kimchi*, and other *kimchi* consumption among consumers were not statistically significant.

The proportion of participants who reported no *kimchi* intake on the day of dietary recall increased continuously throughout the observation period (Fig. 3). Among all participants, the proportion of non-consumers rose from 11.7% in 2010 to 22.7% in 2024; the corresponding values were 10.2% and 20.6% for men and 13.1% and 24.8% for women, respectively.

2. Secular trends in *kimchi* consumption patterns

The changes in the proportion of *kimchi* consumed as a side dish versus as an ingredient in composite dishes among *kimchi* consumers stratified by age group are shown in Fig. 4. The proportion consuming *kimchi* as a side dish declined significantly in all age groups except the 0–9 year group (P for trend < 0.05). The magnitude of decline was greatest in the 20–39 year group ($\beta = -0.888$), followed by the 40–59 year ($\beta = -0.499$) and 10–19 year ($\beta = -0.419$) groups.

Conversely, the proportion consuming *kimchi* in composite dishes increased significantly in most age groups (P for trend < 0.05), with the greatest increase in

the 20–39 year group ($\beta = 0.888$), followed by the 40–59 year ($\beta = 0.499$) and 10–19 year ($\beta = 0.419$) groups.

3. Secular trends in *kimchi* consumption by meal location

Changes in *kimchi* intake according to meal location are shown in Fig. 5. At-home *kimchi* consumption declined significantly in all age groups under 60 years (P for trend < 0.020), with the greatest decreases observed in the 40–59 year ($\beta = -1.352$) and 20–39 year ($\beta = -1.345$) groups, followed by the 10–19 year group ($\beta = -0.613$). At school/workplace settings, *kimchi* intake increased significantly only in the 0–9 year group ($\beta = 0.388$, P for trend < 0.001), while a general declining trend was observed in other age groups, most notably in the 20–39 year group ($\beta = -0.2034$). Restaurant-based *kimchi* consumption exhibited divergent patterns: a declining trend was observed in the 20–39 year group ($\beta = -0.616$, P for trend < 0.001), whereas increasing trends were observed in most other age groups (except those aged 0–9 years), with the greatest increase among adults aged ≥ 60 years ($\beta = 0.276$).

4. Distribution and associated characteristics of *kimchi* consumption (2022–2024)

Kimchi intake was significantly associated with socioeconomic and lifestyle factors (Table 1). Individuals with lower income and educational attainment reported

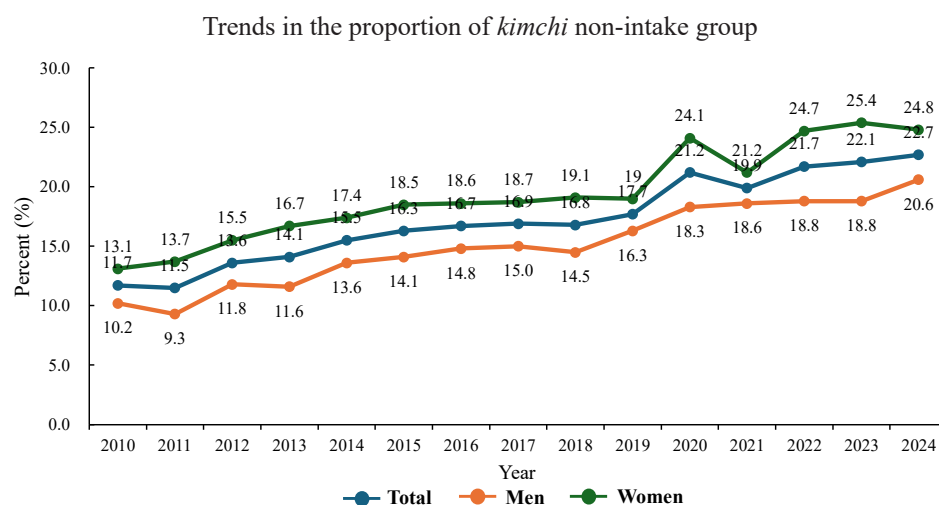


Fig. 3. Trends in the proportion of the *kimchi* non-intake group by gender among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. Values are presented as survey-weighted percentages (%). Blue lines indicate the total population, orange lines indicate men, and green lines indicate women. The *kimchi* non-intake group was defined as participants reporting no *kimchi* consumption on the 24-hour dietary recall day.

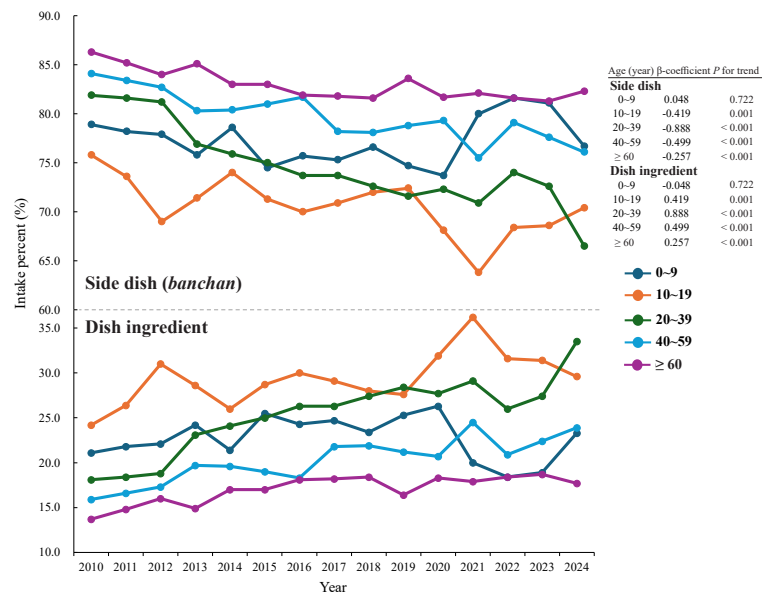


Fig. 4. Age-specific trends in *kimchi* consumption patterns among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the proportion (%) of *kimchi* consumed as a side dish (upper panel) and *kimchi* consumed in dish ingredient (lower panel). Lines represent age groups (0–9, 10–19, 20–39, 40–59, and ≥ 60 years). Values are presented as survey-weighted percentages. β -coefficients represent annual changes in intake proportion estimated using survey-weighted linear regression (PROC SURVEYREG); *P* for trend values were obtained from the same models.

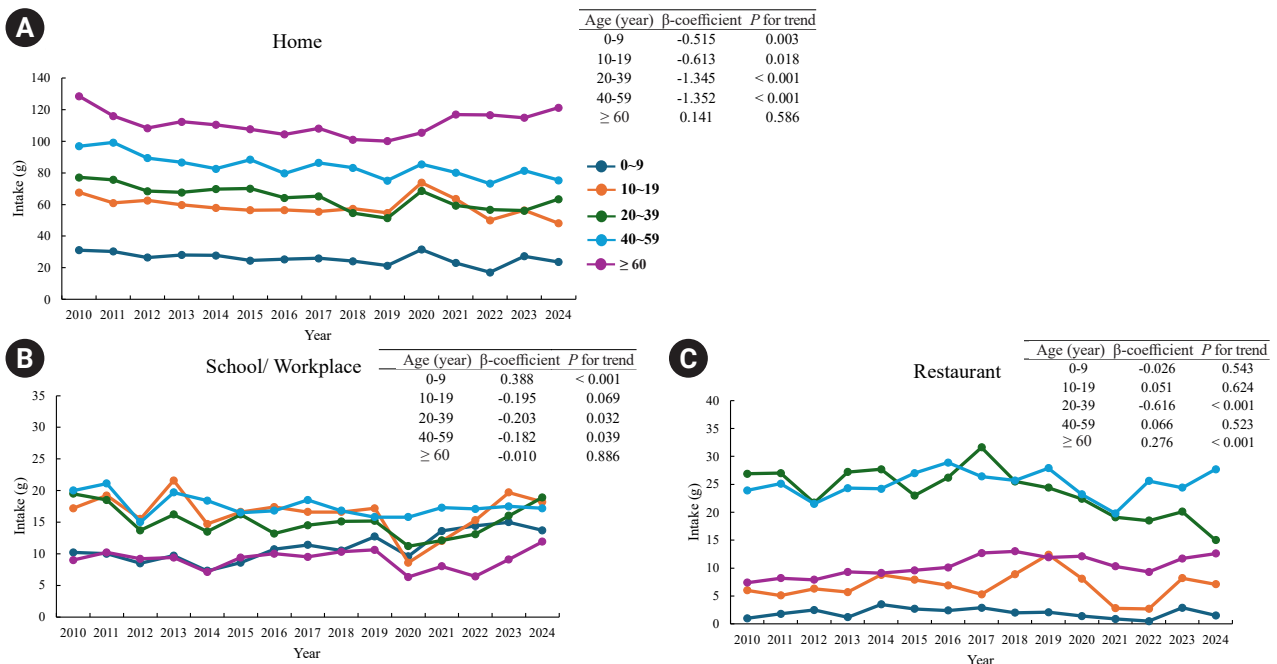


Fig. 5. Age-specific trends in *kimchi* consumption by meal location among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of *kimchi* consumed at home, school/workplace, and restaurants for each age group: (A) home, (B) school/workplace, and (C) restaurant. The values are presented as survey-weighted means. Lines represent age groups (0–9, 10–19, 20–39, 40–59, and ≥ 60 years). β -coefficients represent annual changes in intake estimated using survey-weighted linear regression (PROC SURVEYREG); *P* for trend values were obtained from the same models.

Table 1. *Kimchi* consumption according to general factors

Characteristics	n	Total <i>kimchi</i>	<i>Baechu kimchi</i>	<i>Kkakduki</i>	<i>Yeolmu kimchi</i>	<i>Nabak kimchi</i>	Other <i>kimchi</i>
1. Socioeconomic characteristics							
Income level							
Low	2,920	116.92 ± 3.04	71.18 ± 2.38	7.08 ± 0.71	12.90 ± 1.16	14.18 ± 1.37	11.58 ± 1.07
Lower-middle	3,484	107.16 ± 2.76	66.21 ± 1.95	9.34 ± 0.62	11.46 ± 1.32	8.25 ± 0.83	11.90 ± 0.81
Upper-middle	3,783	99.81 ± 2.16	64.73 ± 1.68	9.03 ± 0.56	9.19 ± 0.83	6.62 ± 0.72	10.23 ± 0.64
High	4,008	95.57 ± 1.99	60.79 ± 1.55	10.33 ± 0.68	7.77 ± 0.71	5.43 ± 0.67	11.25 ± 0.90
P-value		< 0.001	< 0.001	0.004	< 0.001	< 0.001	0.567
Education level							
Middle school	4,146	124.68 ± 2.68	73.13 ± 2.06	8.23 ± 0.60	15.11 ± 1.17	14.73 ± 1.12	13.49 ± 0.89
Graduate or below high school graduate	4,230	107.96 ± 2.07	68.12 ± 1.57	9.82 ± 0.58	9.89 ± 0.82	7.56 ± 0.66	12.56 ± 0.88
University graduate or above	5,450	87.08 ± 1.56	57.55 ± 1.19	9.20 ± 0.45	6.62 ± 0.54	4.43 ± 0.54	9.28 ± 0.54
P-value		< 0.001	< 0.001	0.307	< 0.001	< 0.001	< 0.001
Residential area							
Urban	11,042	98.06 ± 1.42	61.35 ± 1.05	9.04 ± 0.36	9.43 ± 0.65	7.48 ± 0.47	10.77 ± 0.52
Rural	3,202	125.51 ± 4.19	81.45 ± 3.43	9.95 ± 0.73	11.76 ± 1.24	9.24 ± 1.05	13.11 ± 1.10
P-value		< 0.001	< 0.001	0.265	0.096	0.127	0.057
2. Dietary factors							
Eating alone							
None	3,847	125.34 ± 2.56	72.68 ± 1.79	9.95 ± 0.62	14.21 ± 1.12	13.77 ± 1.14	14.73 ± 0.95
1/day	4,895	97.3 ± 1.78	63.88 ± 1.38	9.60 ± 0.54	8.22 ± 0.60	5.65 ± 0.50	9.95 ± 0.64
≥ 2/day	5,502	94.5 ± 1.85	61.04 ± 1.42	8.33 ± 0.47	8.73 ± 0.78	6.20 ± 0.53	10.2 ± 0.51
P-value		< 0.001	< 0.001	0.019	< 0.001	< 0.001	< 0.001
Dining out frequency							
≥ 1/day	2,250	99.55 ± 2.69	66.66 ± 1.96	12.18 ± 0.81	8.05 ± 1.22	4.51 ± 0.73	8.15 ± 0.70
1–6/week	7,243	96.57 ± 1.53	62.11 ± 1.21	8.71 ± 0.42	8.63 ± 0.57	5.72 ± 0.44	11.4 ± 0.56
1–3/month	3,220	114.18 ± 2.68	66.81 ± 2.01	8.68 ± 0.69	13.36 ± 1.11	12.43 ± 1.05	12.90 ± 0.90
Scarcely	1,531	125.58 ± 4.36	74.28 ± 3.28	6.50 ± 0.78	13.71 ± 1.63	18.20 ± 2.07	12.90 ± 1.24
P-value		< 0.001	0.030	< 0.001	< 0.001	< 0.001	< 0.001
Meal frequency							
3/day	9,935	113.66 ± 1.68	68.97 ± 1.28	9.63 ± 0.40	12.37 ± 0.81	9.70 ± 0.58	12.98 ± 0.61
1–2/day	4,309	82.23 ± 1.73	57.05 ± 1.36	8.36 ± 0.52	4.98 ± 0.45	4.11 ± 0.50	7.73 ± 0.49
P-value		< 0.001	< 0.001	0.044	< 0.001	< 0.001	< 0.001
3. Health-related factors							
Alcohol consumption							
No	7,164	98.15 ± 1.73	58.33 ± 1.33	8.14 ± 0.43	11.12 ± 0.72	8.95 ± 0.59	11.60 ± 0.56
Yes	6,821	106.17 ± 1.65	70.04 ± 1.27	10.06 ± 0.44	8.39 ± 0.55	6.76 ± 0.53	10.91 ± 0.61
P-value		< 0.001	< 0.001	0.001	< 0.001	0.002	0.326
Smoking status							
Never smoker	8,578	89.67 ± 1.42	53.6 ± 1.07	7.60 ± 0.35	9.53 ± 0.58	7.99 ± 0.50	10.95 ± 0.55
Past smoker	3,443	120.68 ± 2.35	77.6 ± 1.88	11.64 ± 0.67	10.93 ± 0.90	8.15 ± 0.73	12.36 ± 0.72
Current smoker	1,952	116.87 ± 2.93	81.57 ± 2.32	10.61 ± 0.81	7.89 ± 0.88	6.38 ± 0.84	10.42 ± 0.85
P-value		< 0.001	< 0.001	< 0.001	0.375	0.128	0.876
Physical activity							
No	7,608	105.87 ± 1.78	66.39 ± 1.33	8.87 ± 0.46	10.02 ± 0.63	8.63 ± 0.61	11.95 ± 0.61
Yes	5,528	97.59 ± 1.72	61.55 ± 1.30	9.24 ± 0.44	9.32 ± 0.68	6.70 ± 0.57	10.78 ± 0.61
P-value		< 0.001	0.004	0.540	0.349	0.012	0.128

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Table 1. Continued

Characteristics	n	Total kimchi	Baechu kimchi	Kkakdugi	Yeolmu kimchi	Nabak kimchi	Other kimchi
Obesity ¹⁾							
Underweight	759	94.78 ± 4.95	56.29 ± 3.40	7.83 ± 1.10	11.37 ± 2.07	9.14 ± 1.94	10.15 ± 1.44
Normal	5,093	91.87 ± 1.68	57.58 ± 1.28	7.72 ± 0.48	9.66 ± 0.67	6.87 ± 0.58	10.04 ± 0.55
Overweight	3,280	106.72 ± 2.26	65.98 ± 1.74	10.21 ± 0.62	10.25 ± 0.88	8.35 ± 0.76	11.93 ± 0.75
Obese	5,112	111.91 ± 2.07	72.22 ± 1.57	10.14 ± 0.53	9.53 ± 0.87	8.10 ± 0.64	11.92 ± 0.81
P-value		< 0.001	< 0.001	< 0.001	0.610	0.378	0.032
4. Household factors							
Marital status							
Single	3,692	95.54 ± 2.17	63.38 ± 1.75	7.39 ± 0.55	7.85 ± 0.65	6.81 ± 0.63	10.10 ± 0.73
Married	10,536	105.44 ± 1.53	65.42 ± 1.12	9.83 ± 0.40	10.5 ± 0.70	8.12 ± 0.51	11.56 ± 0.53
P-value		< 0.001	0.270	< 0.001	0.002	0.083	0.074
No. of household members							
1	2,407	107.15 ± 2.87	71.49 ± 2.13	9.25 ± 0.80	8.42 ± 0.78	6.96 ± 0.76	11.04 ± 0.96
2	5,594	111.48 ± 2.25	66.72 ± 1.55	8.76 ± 0.49	12.51 ± 0.9	11.16 ± 0.81	12.33 ± 0.7
3	3,278	96.86 ± 2.48	62.32 ± 1.88	8.99 ± 0.69	8.99 ± 0.79	5.76 ± 0.76	10.80 ± 0.84
4	2,340	93.35 ± 2.69	59.53 ± 1.93	10.44 ± 0.82	7.61 ± 1.29	4.92 ± 0.87	10.85 ± 1.13
5	489	98.8 ± 5.54	67.85 ± 4.36	7.27 ± 1.14	7.41 ± 1.61	9.34 ± 2.75	6.93 ± 2.14
6	136	96.72 ± 11.54	63.33 ± 6.69	11.77 ± 3.4	12.77 ± 7.01	3.53 ± 1.70	5.32 ± 1.69
P-value		< 0.001	< 0.001	0.386	0.042	< 0.001	0.046

Values are presented as weighted means ± standard errors (SE) for continuous variables and weighted percentages for categorical variables, accounting for the complex sampling design. Integrated weights for the period of 2022–2024 were applied.

The numbers of missing values were as follows: education level (n = 418), household income (n = 49), alcohol consumption (n = 259), smoking status (n = 271), physical activity (n = 1,108), and marital status (n = 16).

P-values for differences among survey years were calculated using linear regression models (PROC SURVEYREG) for continuous variables and Rao–Scott chi-square tests (PROC SURVEYFREQ) for categorical variables.

¹⁾Obesity: Underweight (BMI < 18.5 kg/m²), normal (18.5 kg/m² < BMI ≤ 23 kg/m²), overweight (23 kg/m² < BMI ≤ 25 kg/m²), obese (≥ 25 kg/m²).

higher intake of most *kimchi* types, except *kkakdugi* and other *kimchi*. Rural residents consumed significantly greater amounts of total *kimchi* and *baechu kimchi* than did urban residents ($P < 0.001$). Total *kimchi* intake was relatively higher among those who dined alone and those with a lower eating out frequency. Individuals consuming three regular meals per day also reported a higher total *kimchi* intake.

Alcohol consumers and smokers reported relatively higher intake of total *kimchi*, *baechu kimchi*, and *kkakdugi* ($P < 0.05$). Physically inactive individuals and those with obesity also reported generally higher *kimchi* intake across most *kimchi* types ($P < 0.05$). Married individuals showed a tendency toward higher overall *kimchi* consumption, although this association was not statistically significant for all *kimchi* subtypes.

5. Associations between meeting the recommended *kimchi* intake (≥ 40 g/day) and sociodemographic and lifestyle characteristics

Survey-weighted logistic regression identified factors associated with meeting the recommended *kimchi* intake (≥ 40 g/day); base model results are presented by age group (Table 2) and gender (Table 3).

In age-stratified analyses (Table 2), women in the 30–64 year group were significantly less likely to meet the recommended intake than were men (OR 0.61, 95% CI: 0.56–0.68); a comparable association was observed in the ≥ 65 year group (OR 0.60, 95% CI: 0.52–0.69). Alcohol consumers were approximately 30% more likely to meet the recommendation than were non-consumers in both age groups (30–64 years: OR 1.30, 95% CI: 1.17–1.44; ≥ 65 years: OR 1.29, 95% CI: 1.11–1.49); similar positive associations were observed for smokers (current smokers, 30–64 years: OR 1.35, 95% CI: 1.18–1.55; ≥ 65 years: OR 1.31, 95% CI: 1.00–1.72). Rural residents were more like-

Table 2. Age-specific analysis of sociodemographic and health behavior factors associated with *kimchi* intake from 2022 to 2024

Related factors	Total <i>kimchi</i> ≥ 40 g/day vs. < 40 g/day			
	30–64 age group		≥ 65 age group	
	n	OR (95% CI)	n	OR (95% CI)
Gender				
Men	3,797	1.00	2,206	1.00
Women	5,341	0.61 (0.56, 0.68)	2,900	0.60 (0.52, 0.69)
BMI				
Low weight	417	1.05 (0.84, 1.32)	342	0.80 (0.60, 1.07)
Normal weight	3,387	1.00	1,706	1.00
Overweight	1,987	1.19 (1.03, 1.37)	1,293	1.03 (0.86, 1.24)
Obese	3,347	1.22 (1.08, 1.36)	1,765	1.10 (0.93, 1.29)
Education level				
Under middle school	980	1.00	3,166	1.00
High school	3,158	0.88 (0.72, 1.06)	1,072	1.04 (0.87, 1.25)
Beyond college	4,883	0.83 (0.68, 1.01)	567	0.77 (0.61, 0.97)
Household income				
Low	687	1.00	2,233	1.00
Middle-low	1,986	1.22 (0.98, 1.53)	1,498	1.06 (0.88, 1.26)
Middle-high	2,919	1.16 (0.92, 1.45)	864	0.93 (0.75, 1.14)
High	3,518	1.10 (0.88, 1.36)	490	0.86 (0.64, 1.15)
Alcohol consumption				
No	3,885	1.00	3,279	1.00
Yes	5,170	1.30 (1.17, 1.44)	1,651	1.29 (1.11, 1.49)
Smoking status				
Never smoker	5,452	1.00	3,126	1.00
Past smoker	2,087	1.38 (1.22, 1.55)	1,356	1.46 (1.24, 1.73)
Current smoker	1,513	1.35 (1.18, 1.55)	439	1.31 (1.00, 1.72)
Physical activity				
Inactive	4,487	1.00	3,121	1.00
Active	4,063	0.95 (0.85, 1.05)	1,465	1.02 (0.88, 1.19)
Residential area				
Urban	7,505	1.00	3,537	1.00
Rural	1,633	1.28 (1.12, 1.46)	1,569	1.28 (1.06, 1.54)
Marital status				
Single	2,088	1.00	1,604	1.00
Married	7,043	0.99 (0.87, 1.11)	3,493	1.38 (1.19, 1.62)
Eating alone				
None	1,852	1.00	1,995	1.00
1/day	3,854	0.78 (0.68, 0.90)	1,041	0.90 (0.74, 1.08)
≥ 2/day	3,432	0.67 (0.58, 0.78)	2,070	0.76 (0.65, 0.90)
Dining out frequency				
≥ 1/day	2,031	1.00	219	1.00
1–6/week	5,397	0.84 (0.74, 0.94)	1,846	0.85 (0.59, 1.22)
1–3/month	1,367	0.79 (0.67, 0.93)	1,853	0.97 (0.68, 1.39)
Scarcely	343	0.86 (0.64, 1.15)	1,188	0.91 (0.63, 1.33)

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Table 2. Continued

Related factors	Total kimchi ≥ 40 g/day vs. < 40 g/day			
	30–64 age group		≥ 65 age group	
	n	OR (95% CI)	n	OR (95% CI)
Meal frequency				
3/day	5,630	1.00	4,305	1.00
1–2/day	3,508	0.85 (0.76, 0.94)	801	0.70 (0.59, 0.83)

Numbers of missing values were as follows: education level (n = 418), household income (n = 49), alcohol consumption (n = 259), smoking status (n = 271), physical activity (n = 1,108), and marital status (n = 16).

Adjusting for age (continuous), total energy intake (continuous), and total food intake (continuous).

OR, odds ratio; CI, confidence interval; BMI, body mass index.

Table 3. Gender-specific analysis of sociodemographic and health behavior factors associated with kimchi intake from 2022 to 2024

Related factors	Total kimchi ≥ 40 g/day vs. < 40 g/day					
	Total		Men		Women	
	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
Age (year)						
30–64	9,138	1.00	3,797	1.00	5,341	1.00
≥ 65	5,106	1.52 (1.39, 1.66)	2,206	1.57 (1.36, 1.82)	2,900	1.50 (1.35, 1.66)
BMI						
Low weight	759	0.93 (0.78, 1.10)	213	1.10 (0.74, 1.60)	546	0.87 (0.71, 1.07)
Normal weight	5,093	1.00	1,690	1.00	3,403	1.00
Overweight	3,280	1.07 (0.96, 1.20)	1,564	1.09 (0.90, 1.31)	1,716	1.10 (0.95, 1.27)
Obese	5,112	1.09 (0.99, 1.20)	2,536	1.18 (1.00, 1.39)	2,576	1.08 (0.95, 1.22)
Education level						
Under middle school	4,146	1.00	1,428	1.00	2,718	1.00
High school	4,230	1.04 (0.92, 1.18)	1,816	1.22 (0.99, 1.52)	2,414	0.88 (0.75, 1.04)
Beyond college	5,450	0.88 (0.77, 1.02)	2,596	1.00 (0.80, 1.24)	2,854	0.75 (0.63, 0.90)
Household income						
Low	2,920	1.00	1,072	1.00	1,848	1.00
Middle-low	3,484	1.26 (1.11, 1.44)	1,396	1.41 (1.12, 1.79)	2,088	1.16 (0.99, 1.36)
Middle-high	3,783	1.19 (1.03, 1.37)	1,673	1.41 (1.12, 1.78)	2,110	1.05 (0.88, 1.24)
High	4,008	1.14 (0.98, 1.32)	1,848	1.36 (1.08, 1.70)	2,160	0.99 (0.83, 1.18)
Alcohol consumption						
No	7,164	1.00	2,092	1.00	5,072	1.00
Yes	6,821	1.20 (1.10, 1.31)	3,821	1.03 (1.02, 1.03)	3,000	1.04 (0.94, 1.15)
Smoking status						
Never smoker	8,578	1.00	1,325	1.00	7,253	1.00
Past smoker	3,443	1.08 (0.95, 1.22)	2,922	1.10 (0.93, 1.30)	521	1.01 (0.82, 1.24)
Current smoker	1,952	1.06 (0.92, 1.23)	1,656	1.12 (0.94, 1.35)	296	0.90 (0.69, 1.17)
Physical activity						
Inactive	7,608	1.00	3,076	1.00	4,532	1.00
Active	5,528	0.96 (0.88, 1.05)	2,435	1.06 (0.92, 1.23)	3,093	0.89 (0.80, 0.99)
Residential area						
Urban	11,042	1.00	4,595	1.00	6,447	1.00
Rural	3,202	1.24 (1.09, 1.40)	1,408	1.25 (1.05, 1.50)	1,794	1.23 (1.07, 1.41)

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Table 3. Continued

Related factors	Total <i>kimchi</i> ≥ 40 g/day vs. < 40 g/day					
	Total		Men		Women	
	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
Marital status						
Single	3,692	1.00	1,225	1.00	2,467	1.00
Married	10,536	1.16 (1.06, 1.27)	4,772	1.02 (0.87, 1.21)	5,764	1.21 (1.08, 1.35)
Eating alone						
None	3,847	1.00	1,887	1.00	1,960	1.00
1/day	4,895	0.83 (0.74, 0.92)	2,313	0.79 (0.66, 0.94)	2,582	0.88 (0.76, 1.02)
≥ 2/day	5,502	0.73 (0.65, 0.82)	1,803	0.79 (0.66, 0.95)	3,699	0.71 (0.62, 0.81)
Dining out frequency						
≥ 1/day	2,250	1.00	1,435	1.00	815	1.00
1–6/week	7,243	0.93 (0.83, 1.04)	3,005	0.89 (0.76, 1.04)	4,238	0.98 (0.83, 1.17)
1–3/month	3,220	0.96 (0.83, 1.10)	1,110	0.74 (0.59, 0.94)	2,110	1.14 (0.95, 1.37)
Scarcely	1,531	0.87 (0.73, 1.05)	453	0.65 (0.48, 0.89)	1,078	1.10 (0.87, 1.39)
Meal frequency						
3/day	9,935	1.00	4,166	1.00	5,769	1.00
1–2/day	4,309	0.77 (0.70, 0.84)	1,837	0.73 (0.63, 0.85)	2,472	0.81 (0.72, 0.90)

Numbers of missing values were as follows: education level (n = 418), household income (n = 49), alcohol consumption (n = 259), smoking status (n = 271), physical activity (n = 1,108), and marital status (n = 16).

Adjusted for age (continuous), total energy intake (continuous), and total food intake (continuous).

OR, odds ratio; CI, confidence interval, BMI, body mass index.

ly to meet the recommendation than were urban residents in both age groups (30–64 years: OR 1.28, 95% CI: 1.12–1.46; ≥ 65 years: OR 1.28, 95% CI: 1.06–1.54). Conversely, frequent solo dining was significantly inversely associated with meeting the recommendation (≥ 2 solo meals/day: 30–64 years: OR 0.67, 95% CI: 0.57–0.78; ≥ 65 years: OR 0.76, 95% CI: 0.65–0.90), and meal skipping was associated with a 30% lower likelihood than was consuming three meals per day (OR 0.70, 95% CI: 0.59–0.83).

Gender-stratified analyses yielded consistent results (Table 3). Adults aged ≥ 65 years were more likely to meet the recommendation than were those aged 30–64 years across all groups (total: OR 1.52, 95% CI: 1.39–1.66; men: OR 1.57, 95% CI: 1.36–1.82; women: OR 1.50, 95% CI: 1.35–1.66). Women with higher educational attainment were approximately 25% less likely to meet the recommended intake than were those with lower educational attainment. Conversely, men in the highest household income quartile were 36% more likely to meet the recommended intake than were those in the lowest quartile. These findings indicate gender-specific effects of socioeconomic factors on *kimchi* intake.

Frequent solo dining was inversely associated with the likelihood of meeting the recommendation in both genders (total: OR 0.73, 95% CI: 0.65–0.82; men: OR 0.79, 95% CI: 0.66–0.95; women: OR 0.71, 95% CI: 0.62–0.81).

In multivariable-adjusted analyses incorporating sociodemographic and health behavior covariates (Tables 4 and 5), the overall findings were consistent with the base models. The inverse association with woman gender (30–64 years: OR 0.64, 95% CI: 0.56–0.73; ≥ 65 years: OR 0.60, 95% CI: 0.47–0.76), the positive associations with alcohol consumption and rural residence, and the inverse associations with solo dining and meal skipping all persisted after adjustment. Modest attenuation in the effect size was observed for select variables, but the overall directionality of the associations remained unchanged.

DISCUSSION

This study analyzed long-term changes in *kimchi* consumption patterns among Korean adults over a 15-year period (2010–2024) and comprehensively evaluated the sociodemographic, dietary, and health behavior factors

Table 4. Multivariable-adjusted age-specific analysis of sociodemographic and health behavior factors associated with *kimchi* intake from 2022 to 2024

Related factors	Total <i>kimchi</i> ≥ 40 g/day vs. < 40 g/day			
	30–64 age group		≥ 65 age group	
	n	OR (95% CI)	n	OR (95% CI)
Gender				
Men	3,797	1.00	2,206	1.00
Women	5,341	0.64 (0.56, 0.73)	2,900	0.60 (0.47, 0.76)
BMI				
Low weight	417	1.11 (0.87, 1.41)	342	0.73 (0.54, 0.99)
Normal weight	3,387	1.00	1,706	1.00
Overweight	1,987	1.11 (0.96, 1.29)	1,293	0.99 (0.82, 1.20)
Obese	3,347	1.12 (1.00, 1.26)	1,765	1.04 (0.87, 1.24)
Education level				
Under middle school	980	1.00	3,166	1.00
High school	3,158	0.87 (0.71, 1.07)	1,072	0.99 (0.81, 1.21)
Beyond college	4,883	0.83 (0.68, 1.03)	567	0.77 (0.59, 1.00)
Household income				
Low	687	1.00	2,233	1.00
Middle-low	1,986	1.25 (0.99, 1.58)	1,498	0.96 (0.79, 1.15)
Middle-high	2,919	1.18 (0.93, 1.50)	864	0.87 (0.68, 1.12)
High	3,518	1.16 (0.92, 1.47)	490	0.79 (0.56, 1.44)
Alcohol consumption				
No	3,885	1.00	3,279	1.00
Yes	5,170	1.23 (1.10, 1.37)	1,651	1.22 (1.03, 1.45)
Smoking status				
Never smoker	5,452	1.00	3,126	1.00
Past smoker	2,087	1.33 (1.16, 1.51)	1,356	1.38 (1.14, 1.67)
Current smoker	1,513	1.23 (1.06, 1.42)	439	1.20 (0.88, 1.62)
Physical activity				
Inactive	4,487	1.00	3,121	1.00
Active	4,063	0.96 (0.86, 1.07)	1,465	1.05 (0.90, 1.22)
Residential area				
Urban	7,505	1.00	3,537	1.00
Rural	1,633	1.29 (1.12, 1.50)	1,569	1.36 (1.11, 1.66)
Marital status				
Single	2,088	1.00	1,604	1.00
Married	7,043	0.98 (0.84, 1.14)	3,493	1.32 (1.02, 1.69)
Eating alone				
None	1,852	1.00	1,995	1.00
1/day	3,854	0.77 (0.67, 0.89)	1,041	0.97 (0.80, 1.19)
≥ 2/day	3,432	0.69 (0.59, 0.80)	2,070	0.85 (0.69, 1.05)
Dining out frequency				
≥ 1/day	2,031	1.00	219	1.00
1–6/week	5,397	0.86 (0.75, 0.97)	1,846	0.85 (0.58, 1.25)
1–3/month	1,367	0.88, 0.73, 1.06)	1,853	0.93 (0.63, 1.35)
Scarcely	343	0.85 (0.62, 1.17)	1,188	0.91 (0.61, 1.37)

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Table 4. Continued

Related factors	Total <i>kimchi</i> ≥ 40 g/day vs. < 40 g/day			
	30–64 age group		≥ 65 age group	
	n	OR (95% CI)	n	OR (95% CI)
Meal frequency				
3/day	5,630	1.00	4,305	1.00
1–2/day	3,508	0.81 (0.72, 0.90)	801	0.68 (0.56, 0.82)

The number of missing values were as follows: education level (n = 418), household income (n = 49), alcohol consumption (n = 259), smoking status (n = 271), physical activity (n = 1,108), and marital status (n = 16).

Adjusting for age (continuous), total energy intake (continuous), total food intake (continuous), education level, household income, residential area, household composition (single-person household), smoking status, alcohol consumption, and physical activity.

OR, odds ratio; CI, confidence interval, BMI, body mass index.

Table 5. Multivariable-adjusted gender-specific analysis of sociodemographic and health behavior factors associated with *kimchi* intake from 2022 to 2024.

Related factors	Total <i>kimchi</i> ≥ 40 g/day vs. < 40 g/day					
	Total		Men		Women	
	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
Age (year)						
30–64	9,138	1.00	3,797	1.00	5,341	1.00
≥ 65	5,106	1.33 (1.18, 1.51)	2,206	1.42 (1.18, 1.71)	2,900	1.09 (0.93, 1.28)
BMI						
Low weight	759	0.93 (0.78, 1.12)	213	1.10 (0.73, 1.68)	546	0.89 (0.72, 1.11)
Normal weight	5,093	1.00	1,690	1.00	3,403	1.00
Overweight	3,280	1.09 (0.96, 1.22)	1,564	1.03 (0.85, 1.24)	1,716	1.07 (0.92, 1.24)
Obese	5,112	1.10 (1.00, 1.21)	2,536	1.09 (0.92, 1.29)	2,576	1.03 (0.90, 1.17)
Education level						
Under middle school	4,146	1.00	1,428	1.00	2,718	1.00
High school	4,230	1.01 (0.88, 1.16)	1,816	1.13 (0.89, 1.42)	2,414	0.88 (0.74, 1.05)
Beyond college	5,450	0.90 (0.77, 1.05)	2,596	0.91 (0.71, 1.16)	2,854	0.76 (0.63, 0.91)
Household income						
Low	2,920	1.00	1,072	1.00	1,848	1.00
Middle-low	3,484	1.17 (1.02, 1.36)	1,396	1.33 (1.03, 1.73)	2,088	1.07 (0.90, 1.26)
Middle-high	3,783	1.13 (0.96, 1.32)	1,673	1.35 (1.04, 1.76)	2,110	0.98 (0.82, 1.19)
High	4,008	1.12 (0.95, 1.32)	1,848	1.34 (1.03, 1.75)	2,160	0.95 (0.79, 1.15)
Alcohol consumption						
No	7,164	1.00	2,092	1.00	5,072	1.00
Yes	6,821	1.24 (1.13, 1.35)	3,821	1.43 (1.23, 1.65)	3,000	1.03 (0.93, 1.15)
Smoking status						
Never smoker	8,578	1.00	1,325	1.00	7,253	1.00
Past smoker	3,443	1.33 (1.19, 1.48)	2,922	1.02 (0.85, 1.22)	521	1.01 (0.81, 1.25)
Current smoker	1,952	1.25 (1.09, 1.40)	1,656	0.97 (0.80, 1.18)	296	0.84 (0.64, 1.10)
Physical activity						
Inactive	7,608	1.00	3,076	1.00	4,532	1.00
Active	5,528	0.99 (0.90, 1.08)	2,435	1.08 (0.93, 1.25)	3,093	0.89 (0.80, 1.00)
Residential area						
Urban	11,042	1.00	4,595	1.00	6,447	1.00
Rural	3,202	1.32 (1.15, 1.50)	1,408	1.38 (1.12, 1.69)	1,794	1.24 (1.07, 1.44)

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Table 5. Continued

Related factors	Total kimchi ≥ 40 g/day vs. < 40 g/day					
	Total		Men		Women	
	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
Marital status						
Single	3,692	1.00	1,225	1.00	2,467	1.00
Married	10,536	1.12 (1.00, 1.27)	4,772	0.95 (0.76, 1.18)	5,764	1.21 (1.06, 1.40)
Eating alone						
None	3,847	1.00	1,887	1.00	1,960	1.00
1/day	4,895	0.83 (0.74, 0.93)	2,313	0.77 (0.64, 0.92)	2,582	0.93 (0.79, 1.08)
≥ 2/day	5,502	0.73 (0.64, 0.83)	1,803	0.80 (0.65, 0.98)	3,699	0.76 (0.65, 0.88)
Dining out frequency						
≥ 1/day	2,250	1.00	1,435	1.00	815	1.00
1–6/week	7,243	0.87 (0.77, 0.98)	3,005	0.89 (0.75, 1.06)	4,238	0.96 (0.80, 1.16)
1–3/month	3,220	0.90 (0.77, 1.05)	1,110	0.79 (0.60, 1.02)	2,110	1.11 (0.91, 1.37)
Scarcely	1,531	0.84 (0.69, 1.03)	453	0.65 (0.47, 0.92)	1,078	1.09 (0.84, 1.41)
Meal frequency						
3/day	9,935	1.00	4,166	1.00	5,769	1.00
1–2/day	4,309	0.78 (0.71, 0.85)	1,837	0.70 (0.60, 0.82)	2,472	0.83 (0.74, 0.93)

The number of missing values were as follows: education level (n = 418), household income (n = 49), alcohol consumption (n = 259), smoking status (n = 271), physical activity (n = 1,108), and marital status (n = 16).

Adjusting for age (continuous), total energy intake (continuous), total food intake (continuous), education level, household income, residential area, household composition (single-person household), smoking status, alcohol consumption, and physical activity.

OR, odds ratio; CI, confidence interval, BMI, body mass index.

associated with *kimchi* consumption using 2022–2024 data.

The observed changes in *kimchi* consumption trends extend beyond a simple reduction in quantity and may be interpreted as patterns reflective of broader transformations in traditional meal structures and the food consumption environment. The proliferation of single-person households has been identified as a factor associated with the attenuation of traditional *kimjang* culture [23], suggesting that the role of *kimchi* in the Korean diet may have diminished relative to prior generations. The most pronounced decline was observed for *baechu kimchi*; given its dominant share of total *kimchi* consumption, this decline was likely the primary contributor to the overall reduction [24]. In gender-stratified analyses, men reported a higher absolute *kimchi* intake than did women; however, the magnitude of the decline was greater among men. Men tend to consume *kimchi* in large quantities, whereas women tend to consume smaller but more regular amounts [25]; this difference in consumption patterns may explain the observed gender differences in the magnitude of decline.

The transient increase in *yeolmu kimchi* consumption between 2019 and 2020 may be attributable to changes in *kimchi* types served in food service establishments during that period [26]. The possibility that menu diversification and seasonal preferences in home and institutional food service settings synergistically contributed to this transient increase cannot be excluded. Nonetheless, the long-term trend of declining *kimchi* consumption and increasing proportion of non-consumers persisted throughout the observation period, corroborating an overall shift in the role of *kimchi* in the Korean diet.

Another salient finding was the concurrent decrease in *kimchi* as a side dish and an increase in *kimchi* as an ingredient in composite dishes. This shift is consistent with evidence of a transition from the traditional Korean meal structure comprising rice, soup, and side dishes to single-dish meals (e.g., stir-fried rice, stew, and noodle dishes), in which *kimchi* serves as a secondary ingredient, and toward HMR products and processed foods [27]. This trend was most pronounced among adults aged 20–39 years, suggesting an acceleration in generational transitions in dietary culture [28]. These findings

indicate that *kimchi* consumption is being restructured away from traditional meal settings toward diverse food environments and may reflect a shift in supply from home preparation to commercial product purchases and food service or processed food channels [29, 30].

Changes in food consumption according to meal location have important social and scientific implications. The robust maintenance of restaurant-based *kimchi* consumption among older adults reflects consistent cultural food palatability preferences across eating contexts, whereas the sharp decline in at-home *kimchi* consumption among young and middle-aged adults suggests that household size contraction and changes in household structure may be important contextual factors in the erosion of traditional dietary habits. These findings align with prior logistic model-based analyses that reported a significant 0.34% increase in the probability of consuming *kimchi* at meals per additional year of age ($P < 0.001$), indicating that *kimchi* remains a central mealtime component in older adults [31].

Lower income and educational attainment were associated with relatively higher *kimchi* intake; these associations were broadly maintained in multivariable-adjusted models (Tables 4 and 5). Dietary diversification tends to accompany a higher socioeconomic status, and individuals with greater economic resources were more likely to consume a wider variety of food groups rather than relying predominantly on a single food category [32]. This may reflect a structural dietary change in which the traditional role of *kimchi* as a primary vegetable source is being replaced by a more diverse array of food groups. In addition to its role as a major vegetable source, *kimchi*, as a fermented food, is recognized as a dietary component associated with the gut microbiome and metabolic health. Accordingly, declining *kimchi* intake may not simply represent a change in the consumption of a single food, but may reflect broader dietary structural changes in fermented food and vegetable intake patterns, warranting further investigation relative to overall dietary quality and chronic disease risk. Gender-specific differences were also apparent; women with higher educational attainment showed lower compliance with the recommended intake in multivariable analyses, whereas men with higher household income showed greater compliance. These findings suggest that women

with higher education may more actively pursue dietary diversification and health-conscious food choices, whereas men's dietary habits may be relatively stable, irrespective of income level [33]. As socioeconomic variables contributing to dietary behavior differ by gender, these findings underscore the need for gender-stratified, economically sensitive nutritional education strategies.

The consistently higher *kimchi* intake among rural versus urban residents, maintained in multivariable-adjusted models, contrasts with the Westernization of dietary habits and increased reliance on eating-out and processed foods, which are characteristic of urban settings. Married individuals were more likely to meet the recommended intake than are single individuals, which may be related to a higher frequency of home-based meals and greater meal regularity [34]. Higher frequency of solo dining, meal skipping, and lower meal frequency were all significantly and inversely associated with *kimchi* intake after multivariable adjustment, suggesting that dietary changes associated with the rise of single-person households and the spread of solo dining culture may contribute to the decline in traditional side dish consumption [35, 36]. Alcohol consumption and smoking were positively associated with *kimchi* intake, potentially attributable to increased consumption of savory accompaniments during drinking or a preference for pungent and spicy flavors [37, 38]. Higher odds of meeting the recommended *kimchi* intake among individuals with obesity may reflect elevated total food intake or palatability-driven eating behaviors, rather than an independent effect of *kimchi* per se [39]. In multivariable analyses, underweight adults aged ≥ 65 years showed lower compliance with the recommended intake, possibly reflecting generalized reductions in food intake and nutritional inadequacy associated with aging.

In summary, the trends observed in *kimchi* consumption may be concomitant with broader changes in meal composition and overall dietary behavior. Future public health strategies should shift from pursuing increases in *kimchi* intake to dietary pattern-centered approaches that consider overall diet quality and balance, including total energy and sodium intake, with *kimchi* embedded within that broader context [40]. These findings highlight the need for tailored nutritional education and

food environment improvement strategies that reflect the changing dietary landscape of young adults and single-person households.

Limitations

The present study has some limitations. First, as the study relied on single-day 24-hour dietary recall data, the findings reflect dietary intake on the day of assessment rather than long-term habitual dietary patterns. In particular, ‘non-consumers on the dietary recall day’ should not be equated with habitual abstainers, and the potential for non-differential misclassification of *kimchi* consumption status should be acknowledged. Therefore, the results should be interpreted as reflecting changes in consumption patterns rather than absolute intake levels.

Second, the quantities of food within composite dishes in the KNHANES were estimated based on national standardized recipes and may not fully capture the variability in *kimchi* content attributable to actual preparation methods in home or restaurant settings. Furthermore, while intake weight (g) was used as the unit of analysis, *kimchi* incorporated into heat-processed composite dishes (e.g., stews and stir-fry) may exhibit nutritional properties different from those of raw *kimchi* (e.g., changes in sodium concentration), a factor not accounted for in the current analyses.

Third, while consumption form was classified as ‘side dish’ or ‘ingredient in a composite dish’ by linking food codes (N_FCODE) with dish codes (N_DCODE), classification of certain composite dishes relied on dish names and standardized recipe-based information, precluding complete disambiguation of consumption form. When the same dish name encompasses different preparation methods or *kimchi* usage, the possibility of nondifferential misclassification cannot be entirely excluded.

Fourth, the cross-sectional study design precluded a causal interpretation of the observed associations. Notwithstanding, the present study contributes to the literature by comprehensively analyzing quantitative and qualitative changes in *kimchi* consumption over approximately 15 years using the most recent large-scale nationally representative data through 2024 and provides a multidimensional evaluation of traditional

food culture changes and associated dietary patterns by simultaneously considering consumption form and meal environment.

Conclusion

The findings of the present study suggest that the role of *kimchi* in everyday eating is undergoing a structural transformation and raise the need for a reexamination of nutritional policies and food cultural approaches predicated on conventional *kimchi* consumption patterns. Therefore, future strategies to promote *kimchi* consumption should extend beyond the preservation of traditional food cultures and encompass practical approaches that reflect contemporary dietary patterns and living environments. These findings provide foundational evidence for policy formulation aimed at improving dietary quality and fostering the contemporary succession of traditional Korean food culture among the Korean population.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to a conflict of interest.

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DATA AVAILABILITY

All the data and materials are publicly available on the KNHANES website (<https://knhanes.kdca.go.kr/knhanes/main.do>).

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Research Article

지역사회 거주 노인 대상 사회인지이론의 구성요소와 범이론적 모델 기반 상담을 반영한 지역사회 영양중재의 효과: 비동등성 대조군 전후 설계 연구

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Effect of a community-based nutrition intervention incorporating social cognitive theory constructs and transtheoretical model-based counseling among community- dwelling elderly in Korea: a quasi-experimental study

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Objectives: This study evaluated the effects of a 7-week nutrition intervention based on the personal and environmental constructs of social cognitive theory (SCT) and the transtheoretical model (TTM) on dietary behavior-related factors, dietary behavior outcomes, and stages of dietary behavior change among community-dwelling older adults.

Methods: A quasi-experimental nonequivalent control group pretest–posttest design was conducted from May to December 2024 at seven senior facilities in Seoul and Gyeonggi, Korea. Older adults aged ≥ 65 years were assigned by facility to either an intervention group (n = 66; four facilities) or a control group (n = 65; three facilities). The intervention group completed a 7-week program consisting of baseline assessment, five weekly group education sessions, individualized nutrition counseling, and post-intervention assessment. The control group received one general nutrition education session. Outcomes included dietary knowledge, outcome expectations, value expectations, self-efficacy, environmental factors (food accessibility and household food availability and social support), dietary behavior outcomes assessed using the Nutrition Quotient for the Elderly (NQ-E), and stage of change. Program effects were analyzed using ANCOVA adjusted for age, family composition, education, baseline dietary knowledge, and value expectations.

Results: Compared with the control group, the intervention group demonstrated significantly greater improvements in dietary knowledge ($P < 0.001$), outcome expectations ($P = 0.018$), self-efficacy ($P < 0.001$), environmental factors ($P < 0.001$), and NQ-E total score (P

= 0.011). No significant between-group difference was observed for value expectations. The proportion of participants in the action stage increased from 9.1% to 93.9% in the intervention group, and post-intervention stage distribution differed significantly between groups ($P < 0.001$). Program satisfaction was high (4.69 ± 0.41).

Conclusion: A 7-week nutrition intervention incorporating SCT-based personal and environmental constructs and TTM-based stage-matched counseling improved dietary behavior-related factors, dietary behavior outcomes, and stage distribution among community-dwelling older adults.

Keywords: aged; nutrition education; social cognitive theory; transtheoretical model; nutrition quotient

INTRODUCTION

전 세계적인 인구 고령화의 가속으로 고령층에서의 만성질환 부담은 빠르게 증가하고 있으며 세계 공중보건의 과제로 제기되고 있다[1, 2]. 이러한 국제적 흐름 속에서 우리나라는 2024년 말 기준 초고령사회에 진입하였으며, 지역사회 기반의 예방·관리 전략의 필요성이 더욱 부각되고 있다[3]. 2023년 노인실태조사에서는 노인의 만성질환 보유 개수가 평균 2.2개이며, 전체 노인의 63.9%가 2개 이상의 만성질환을 동시에 보유한 복합이환자라고 보고하였다[4]. 만성질환의 증가는 의료비 부담을 증대할 뿐 아니라, 노인의 신체적·정신적 건강에도 부정적인 영향을 미치며, 삶의 질 저하와도 밀접하게 연관된다는 연구가 지속적으로 보고되고 있다[5, 6].

노년기 식생활은 생리적 변화(식욕 저하, 저작·소화 기능 저하 등)와 사회경제적 요인(식품 접근성, 사회적 지지, 정보 이해·활용 능력 등)이 중첩되면서 취약해지기 쉽다[4, 5]. 특히 건강정보의 이해·활용 능력과 정보 접근성의 격차는 식생활 실천의 격차로 이어질 수 있어, 단순한 정보 제공을 넘어 ‘이해-결정-실천’의 과정을 수행하도록 돕는 지원 전략이 요구된다[7]. 국민건강영양조사를 활용한 국내 연구에서는 연령이 높아질수록 에너지와 단백질, 칼슘, 비타민 A 등 필수 영양소 섭취 부족이 증가하고, 식사의 질이 저하될 수 있음을 보고하였다[6, 8, 9]. 또한 식품안전성이 낮은 노인은 에너지와 단백질을 포함한 주요 영양소 섭취가 더 부족하고 건강 관련 삶의 질도 낮게 나타나, 영양 문제는 개인 선택뿐 아니라 환경적 요인도 함께 고려해야 함을 시사한다[10]. 이러한 배경에서 정부는 제5차 국민건강증진종합계획(Health Plan 2030)을 통해 노년기 영양관리를 국가 보건정책의 중점 과제로 제시하고, 노인 맞춤형 영양관리 기반 강화와 지역사회 지원 서비스 확충을 명시하고 있다[11]. 또한, 2025년 지역사회통합건강증진사업 안내서(영양)에서도 노인 대상 영양관리의 실행 기준을 제시하고 있다[12].

그러나 현장에서는 전문 인력과 예산 제약으로 인해 노인 영

양교육이 단발성·대규모 강의식 수업이 주로 운영되고 있어 노인의 행동 변화를 유도하고, 지속적으로 유지하기에는 한계가 있다[13]. 특히 최근 국내 노인 대상 영양교육 매체를 범이론적 모델(transtheoretical model, TTM)과 먹거리 이해력(food literacy) 관점에서 분석한 주제범위 문헌고찰에서는, 카드뉴스·동영상 등 정보 전달형 매체가 중심이며, 행동변화단계의 고려 전·고려 단계에 해당하는 주제가 가장 큰 비중을 차지하는 것으로 보고되었다[14]. 다시 말해, 현재의 매체 기반 정보 제공만으로는 노인의 행동변화단계별로 요구되는 기술 습득, 자기조절, 환경적 지지까지 포괄하기 어렵고, 맞춤형 교육을 위해 단계별 전략과 다양한 영역의 이해력을 반영한 자료 개발이 필요하다고 제안하였다[14].

사회인지이론(social cognitive theory, SCT)은 행동 변화를 목표로 하는 영양중재 프로그램에 자주 활용되는 이론으로 개인적·환경적·행동적 요인이 상호작용하면서 영향을 미친다는 상호결정론을 토대로 한다[15-17]. 특히, 자아효능감은 건강행동의 선택과 지속에 중요한 요인이며, 지식, 결과기대와 같은 인지적 요인과 강화와 모델링 같은 환경적 요인이 함께 설계될 때 행동변화의 가능성이 커진다[16-19]. 한편 TTM은 고려전-고려-준비-행동-유지로 이어지는 단계별 개념으로, 개인의 행동변화단계에 따라 전략을 달리해야 함을 강조한다[20-22]. 즉, 노인 식생활 개선처럼 습관이 고착되고 장애요인이 복합적인 과제에서는, SCT가 제시하는 변화 기제(예: 자아효능감 강화, 환경적 지지 설계)와 TTM의 단계별 맞춤 전략을 통합한 접근이 지식 향상을 넘어 실천의 지속에 도달하기 위한 합리적 틀이 될 수 있다[16, 20-22]. 그러나 국내에서 노인을 대상으로 SCT 또는 TTM을 단독으로 적용한 연구는 거의 없는 실정이며, 특히 두 이론을 통합하여 프로그램의 효과와 현장 재현성까지 고려한 중·장기 중재의 근거 역시 부족하다[23, 24]. 또한 앞선 문헌고찰 결과처럼 실제 현장에서 유통되는 교육 매체가 행동 전 단계에 편중되어 있다는 점은[14], 프로그램 개발 시 단계별 요구도를 충족하도록 구조화되고, 상담·피드백·환경 조정이 결합

되어야 함을 뒷받침한다.

이에 본 연구는 지역사회 노인을 대상으로 SCT의 개인적·환경적 구성요소와 TTM을 중심으로 참고하여 설계한 맞춤형 영양중재 프로그램을 개발·적용하고, 중재 전후 인지적 요인(식생활 지식, 결과기대, 가치기대, 자아효능감), 환경적 요인, 식행동 지표[노인 영양지수(Nutrition Quotient for the Elderly; NQ-E)] 및 행동변화단계의 변화를 평가하여 프로그램의 효과를 검증하고자 한다. 본 연구에서는 영양중재 프로그램에 참여한 중재군이 대조군에 비해 개인적·환경적 요인, 식행동 지표 및 행동변화단계에서 보다 긍정적인 변화를 보일 것이라는 가설을 설정하였다. 본 연구 결과는 노인 영양교육이 정보 제공을 넘어 행동 변화의 전 과정으로 확장되기 위한 실천 모델과 교육·상담 전략을 제시하는 근거로 활용될 수 있을 것이다.

METHODS

Ethics statement

This study was approved by the Institutional Review Board of Sungshin Women's University (IRB No. SSWUIRB-2024-013). Written informed consent was obtained from all participants prior to participation.

1. 연구설계

본 연구는 비동등성 대조군 전후설계(quasi-experimental design with nonequivalent control group pretest-posttest) 연구로, TREND statement (Transparent Reporting of Evaluations with Nonrandomized Designs)의 보고지침에 따라 기술하였다.

2. 연구대상

연구의 대상자는 2024년 5월부터 12월까지 서울 및 경기 지역 7개 노인시설을 이용하는 65세 이상 노인으로, 연구 참여에 동의한 자를 모집하였다. 모집 기관은 대부분 노인종합복지관이었고, 1개 기관은 천주교 운영 시니어 아카데미였다. 대상자의 선정 기준은 일상생활이 가능하고, 인지기능이 정상 범위에 속하는 노인으로서 식생활 관리에 대한 관심이 있으며, 프로그램에 결석하지 않고 참여할 수 있는 자로 설정하였다. 표본 수는 G*Power 3.1 프로그램을 이용하여 산정하였다. 유의수준 0.05, 검정력 0.80, 효과크기 0.50, 양측검정을 기준으로 계산한 결과 집단별 최소 64명이 필요하였으며, 탈락률을 고려하여 중재군 80명, 대조군 80명, 총 160명을 모집하고자 하였다. 대상자의 모집은 각 노인시설과 협의로 이루어졌으며, 중재의 확산을 방지하기 위해 중재군 4개 기관과 대조군 3개 기관에서 대상자를 서로 독립적으로 모집하였다. 따라서 집단 배정은 시설 단위로 이루어졌으며, 동일 시설 내 참여자들은 동일한 중재 조건에 노출되도록 하였다. 총 160명을 모집하였으나, 이 중 29명은 제외

(출석을 낮은 16명, 불성실 응답 13명)하여 131명이 최종 분석 대상이다. 중재군은 7주 프로그램(1주차 오리엔테이션 및 사전 평가, 2-6주차 주 1회 집단교육과 개인별 영양상담, 7주차 사후 평가 및 프로그램 총정리)에 참여하였으며, 대조군은 연구 시작 시점에 1회의 일반 영양교육을 제공받았다. 연구대상자 모집 및 선정 과정은 Fig. 1에 제시하였다.

3. 영양중재 프로그램

본 연구의 영양중재 프로그램은 SCT의 개인적·환경적 구성요소를 중심으로 설계한 집단교육과 TTM에 근거한 개인별 영양상담을 통합한 7주 프로그램으로 구성하였다. 1회차에는 오리엔테이션, 사전 조사, 행동변화단계 평가 및 목표 설정을 실시하였고, 2-6회차에는 주 1회 집단교육과 대면·비대면 개인상담을 병행하였으며, 7회차에는 사후 평가를 실시하였다. 집단교육은 균형 잡힌 식생활, 규칙적인 생활 습관, 저작·연하 기능 관리, 대사증후군 예방 및 관리, 실천하는 식생활을 주제로 구성하였다. 집단교육은 건강한 식생활 원칙과 실천 방법에 대한 이해를 높여 식생활 지식, 결과기대, 가치기대를 강화하도록 설계하였고, 개인별 상담은 식생활 문제 점검, 맞춤형 목표 설정, 회차별 실천 과제와 피드백 제공을 통해 자아효능감을 강화하도록 구성하였다. 또한 실생활 중심 교육 내용과 상담 과정에서의 목표 점검을 통해 참여자가 자신의 식생활 환경을 보다 건강한 방향으로 인식하고 활용하도록 하여 환경적 요인을 반영하였다. TTM은 개인상담 과정에서 행동변화단계에 따른 맞춤형 상담 전략을 적용하는 틀로 활용하였다. 예를 들어, 고려 전·고려 단계에서는 건강한 식생활의 필요성 인식과 변화의 이점·장애요

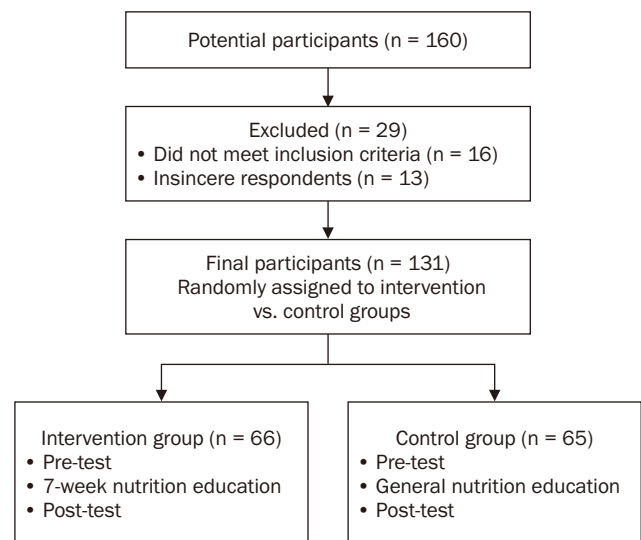


Fig. 1. Flowchart of participant recruitment, allocation, and analysis.

인 탐색에 중점을 두었고, 준비 단계에서는 개인별 실천목표 설정과 구체적 행동계획 수립을, 행동 단계에서는 실천 점검, 어려움 해결, 피드백과 재강화를 중심으로 상담하였다. 본 프로그램의 목표는 대상자의 행동변화단계에 맞는 맞춤형 목표 설정과 상담을 통해 식생활 실천을 촉진하고, 행동 단계로의 상향 이동을 유도하는 것이었다. SCT의 개인적·환경적 요인은 이러한 변화 과정을 지원하는 기제로 반영하였으며, NQ-E는 그 결과 실제 식행동 수준이 개선되었는지를 평가하기 위한 결과 지표로 활용하였다. 즉, 개인별 영양상담에서는 각 대상자의 행동 변화단계에 따라 서로 다른 실천 목표와 과제를 설정하였으며, 프로그램의 직접 목표는 개별 목표를 동일하게 달성하게 하는 것이라기보다 각자의 단계에 맞는 식생활 실천을 촉진하여 행동변화단계의 상향 이동을 유도하는 것이었다. 효과 평가는 개별 목표 달성 여부 자체를 별도로 점수화하여 분석한 것이 아니라, 모든 참여자에게 공통적으로 적용 가능한 지표인 행동변화 단계의 전후 변화와 식행동 결과 지표(NQ-E)의 변화를 통해 확인하였다. 교육매체는 강사용 회차별 교육안, 교육 대상자용 시 각자료(PPT), 참여자용 교재로 구성하였다.

4. 자료수집 및 측정도구

자료수집은 프로그램 시작 전(사전)과 종료 후(사후) 두 차례에 걸쳐 구조화된 설문지로 측정하였다. 설문지는 SCT의 개인적·환경적 요인, 행동변화단계, 식행동 결과 지표를 평가할 수 있도록 구성하였다. 설문 문항은 SCT 및 TTM 관련 문헌과 노인 대상 영양교육 선행연구를 참고하여 구성하였으며[13], 식행동 결과 지표는 NQ-E를 사용하였다[25]. 또한, 노인의 이해도와 시력 등을 고려하여 글씨 크기와 용어를 조정하였고, 응답의 정확도를 높이기 위해 훈련된 조사가원이 일대일 면담을 통해 최종 확인하였다.

1) 사회인지이론의 개인적·환경적 요인

본 연구에서는 SCT의 인지적 요인(식생활 지식, 결과기대, 가치기대, 자아효능감), 환경적 요인(식품 접근성 및 가정 내 식품 가용성, 사회적 지지)을 평가하였다. 인지적 요인에는 식생활 지식(10문항), 결과기대(5문항), 가치기대(5문항), 자아효능감(6문항)을 포함하였다. 식생활 지식은 정답-오답형(정답 1점, 오답 0점)으로 점수화 하였으며, 그 외 변수는 5점 Likert 척도로 평가하였다(1점 = 전혀 그렇지 않다, 5점 = 매우 그렇다). 점수가 높을수록 인지적 요인이 긍정적으로 작용함을 의미한다. 환경적 요인은 식품 접근성 및 가정 내 식품 가용성(4문항)과 사회적 지지(2문항)로 구성하였다. 식품접근성 및 가정 내 식품 가용성 문항은 “우리 집은 식품을 구매하기 위한 시장(마트)이 가까운 편이다”, “나는 식품을 구매하기 위해 시장(마트)을 가거나 배달 서비스를 이용하는 것이 어렵지 않은 편이다”, “우리 집에는 여러 가지 식재료나 반찬이 있는 편이다”, “우리 집에는 과일

이나 우유 등의 건강 간식이 있는 편이다”로 구성하였으며, 이는 객관적인 지역 식품환경 자체보다는 참여자가 인식하는 식품 구매 및 이용의 용이성과 가정 내 식품 구비 수준을 평가하기 위한 문항이다. 사회적 지지 문항은 “나는 가족이나 친구들과 식생활에 대한 이야기를 많이 나누는 편이다”, “나의 가족이나 친구들은 식생활에 대한 관심이 많은 편이다”로 구성하였으며, 이는 건강한 식생활과 관련하여 참여자가 일상에서 경험하는 대인적 지지, 즉 가족·친구의 관심 및 상호작용에 대한 인식을 평가하기 위한 것이다. 점수가 높을수록 환경적 요인이 긍정적임을 의미한다. 본 연구의 환경적 요인은 객관적인 지역 식품 환경이나 가족 환경의 실제 변화를 측정하기보다, 참여자가 인식하는 식품 구매 및 이용의 용이성, 가정 내 식품 가용성, 그리고 건강한 식생활 관련 사회적 지지를 평가하도록 구성하였다. 본 연구에서는 설문 문항의 구성 타당성과 내적 일관성을 확인하기 위해 EFA와 Cronbach's α 를 함께 검토하였다. 결과기대는 KMO 0.817, Cronbach's α 0.857로 확인되었다. 가치기대는 KMO 0.806, Cronbach's α 0.829로 확인되었다. 자아효능감은 두 하위요인으로 구분되었으며, 전체 KMO는 0.688이었고, 하위요인의 Cronbach's α 는 각각 0.811과 0.621이었다. 환경적 요인 역시 두 하위요인으로 구분되었으며, 전체 KMO는 0.603이었고, 하위요인의 Cronbach's α 는 각각 0.573과 0.645였다. 이를 바탕으로 최종 문항 구성을 확정하였다.

2) 행동변화단계

행동변화단계는 TTM에 근거하여 고려 전(precontemplation), 고려(contemplation), 준비(preparation), 행동(action), 유지(maintenance)의 5단계로 구분하여 자료를 수집하였다. 행동변화단계는 “평소 여러 음식을 골고루, 알맞게, 규칙적으로 먹고 있습니까?”라는 1문항을 바탕으로 평가하였으며, 응답은 TTM에 따라 5단계로 구분하였다. 최종 단계는 영양사가 개별 영양상담 과정에서 실천 여부와 지속기간을 확인한 후 분류하였다. 그러나 단계별 분포를 확인한 결과 유지단계를 포함한 일부 범주의 표본 수가 매우 적어 범주별 기대빈도가 충분하지 않았으며, 이에 따라 통계적 안정성과 해석의 명확성을 높이기 위해 고려전·고려(precontemplation & contemplation), 준비(preparation), 행동(action)의 3단계로 재분류하여 분석하였다. 또한, 개인별 영양상담에서는 각 대상자의 행동변화단계에 따라 목표 설정과 실천 과제를 차등 적용하였으며, 효과 평가는 중재 전후 행동변화단계의 분포 변화와 공통 결과 지표의 변화를 통해 확인하였다.

3) 식행동 결과 지표

NQ-E는 식품의약품안전처와 한국영양학회가 공동 개발한 도구로, 본 연구에서는 SCT의 행동적 구성요인을 직접 측정하는 지표라기보다 중재 후 실제 식행동 수준의 변화를 평가하기 위

한 식행동 결과 지표로 활용하였다. 본 도구는 타당도와 신뢰도가 이미 검증되어 있으며, 균형, 절제, 실천의 세 영역 점수와 총점을 산출하여 평가하였다.

5. 통계분석

수집된 자료는 IBM SPSS Statistics 29 (IBM Corp., Armonk, NY, USA)를 이용하여 분석하였으며, 통계적 유의수준은 $P < 0.05$ 로 설정하였다. 먼저, 연구대상자의 일반적 특성과 주요 변수의 분포를 확인하기 위해 빈도분석과 기술통계(평균, 표준편차, 백분율)를 실시하였다. 설문 평가도구의 신뢰도와 타당도를 검증하기 위해 탐색적 요인분석(exploratory factor analysis, EFA)과 내적 일관성 검증(Cronbach's α)을 수행하였다. 사전 동질성 검증은 독립표본 t-검정(independent t-test)과 χ^2 -검정(chi-square test)을 실시하였으며, 그 결과 성별, 연령, 가족구성, 학력, 식생활 지식, 가치기대에서 집단 간 유의한 차이가 확인되었다. 이에 프로그램 효과 분석 시 연령, 가족구성, 학력, 식생활 지식, 가치기대를 공변량(covariates)으로 설정하여 공분산분석(analysis of covariance; ANCOVA)을 실시함으로써 사전 차이를 통제한 상태에서 집단 간 차이를 검정하였다. 성별은 주요 변수의 보정 값과 P 값에 영향을 미치지 않아 공변량에서 제외하였다. 프로그램 시행 전·후의 인지적 요인(식생활 지식, 결과기대, 가치기대, 자아효능감), 환경적 요인, 식행동 결

과 지표(NQ-E)의 변화를 비교하기 위해 대응표본 t-검정을 실시하였다. 행동변화단계는 동일 대상자에서 중재 전과 후에 반복 측정된 범주형 자료이므로, 집단 내 전후 단계 분포 변화는 교차표를 통해 확인하였다. 3단계로 재분류한 전후 분포가 정사각 분할표(square table)를 이루는 경우에는 McNemar-Bowker 검정을 적용하였으며, 정사각 분할표가 성립하지 않는 경우에는 교차표와 분포 변화 양상을 중심으로 해석하였다. 프로그램 효과의 주요 비교는 사후 행동변화단계 분포의 집단 간 차이로 판단하였고, 이는 χ^2 -검정을 이용하여 분석하였다. 또한 추가로 Fisher-Freeman-Halton exact test를 실시하여 결과의 일관성을 확인하였다. 사전-사후 변화는 집단 내 변화 양상을 제시하기 위한 것이며, 프로그램 효과의 주요 해석은 공변량을 보정한 ANCOVA와 사후 행동변화단계의 집단 간 비교 결과를 기준으로 하였다.

RESULTS

1. 연구대상자의 일반적 특성

연구대상자의 일반적 특성은 Table 1에 제시하였다. 전체 131명 중 중재군은 66명(50.4%), 대조군은 65명(49.6%)이었으며, 평균 연령은 74.60 ± 6.19 세였다. 대상자의 대부분은 여성(93.1%)이었다. 집단 간 동질성 검정 결과, 성별($P = 0.006$), 연령($P =$

Table 1. Homogeneity test for general characteristics of participants (n = 131)

Characteristics	Intervention (n = 66)	Control (n = 65)	P-value
Sex			0.006
Male	9 (13.6)	0 (0.0)	
Female	57 (86.4)	65 (100)	
Age (year)	73.39 ± 6.02	78.82 ± 6.16	0.025
Family type			0.012
Living alone	16 (24.2)	30 (46.2)	
Living with spouse	24 (36.4)	18 (27.7)	
Living with children	7 (10.6)	11 (16.9)	
Living with spouse and children	15 (22.7)	5 (7.7)	
Others	4 (6.1)	1 (1.5)	
Education level			< 0.001
≤ Elementary school	8 (12.1)	18 (27.7)	
Middle school	7 (10.6)	15 (23.1)	
High school	22 (33.3)	24 (36.9)	
≥ University	29 (43.9)	8 (12.3)	
Economic support status			0.478
NBLS recipient	4 (6.1)	7 (10.8)	
Low-income	5 (7.6)	7 (10.8)	
None	57 (86.4)	51 (78.5)	

n (%) or Mean $\pm$ SD.

P-values were obtained using the chi-square test or independent t-test, as appropriate.

NBLS, national basic livelihood security.

0.025), 가족구성($P = 0.012$), 학력($P < 0.001$)에서 유의한 차이가 나타났으며, 경제적 지원 상태에서는 통계적으로 유의한 차이가 관찰되지 않았다($P = 0.478$).

2. 인지적 요인의 변화

인지적 요인의 변화는 Table 2에 제시하였다. 식생활 지식, 결과기대, 가치기대, 자아효능감의 변화를 분석한 결과, 식생활 지식 점수는 중재군에서 사전 10.03 ± 1.99 점에서 사후 12.67 ± 1.24 점으로 증가하여, 실제 평균 변화량은 2.64점이었고, 보정된 평균 변화량이 2.80 ± 0.19 점으로 나타났으며, 이는 대조군의 변화량(0.87 ± 0.19 점)보다 1.93점 더 큰 변화였다($P < 0.001$). 이러한 결과는 본 프로그램이 노인의 식생활 관련 지식 향상에 실질적으로 기여하였음을 보여준다. 결과기대 총점은 중재군에서 사전 20.68 ± 2.61 점에서 사후 21.86 ± 2.49 점으로 1.18점 증가하였고, 보정된 평균 변화량이 1.54 ± 0.39 점으로 나타났으며, 이는 대조군의 변화량(0.14 ± 0.39 점)보다 1.40점 더 큰 변화였다($P = 0.018$). 결과적으로, 건강한 식생활 실천이 가져올 긍정적 결과에 대한 인식이 강화된 것으로 해석할 수 있다. 반면 가치기대 총점은 중재군과 대조군 모두 사전 대비 소폭 증가하였으나, 집단 간 보정된 변화량의 차이는 통계적으로 유의하지 않았다($P = 0.194$). 가치기대는 단기간의 교육 중재만으로는 크게 변하지 않는 비교적 안정적인 동기 요인일 가능성을 시사한다. 자아효능감 총점은 중재군에서 사전 22.12 ± 2.60 점에서 사후 24.33 ± 2.75 점으로 2.21점 증가하였고, 보정된 평균 변화량이 2.33 ± 0.36 점으로 나타났으며, 이는 대

조군의 변화량(0.33 ± 0.36 점)보다 2.00점 더 큰 변화였다($P < 0.001$). 전반적으로 인지적 요인 중 식생활 지식, 결과기대, 자아효능감에서 중재군의 증가폭이 더 크게 나타났다. 이와 같은 변화는 중재군에서 건강한 식생활을 실제로 실천할 수 있다는 자신감이 강화되었음을 보여준다.

3. 환경적 요인의 변화

환경적 요인의 변화는 Table 3에 제시하였다. 식품 접근성 및 가정 내 식품 가용성, 사회적 지지, 환경적 요인 총점의 변화를 분석한 결과, 식품 접근성 및 가정 내 식품 가용성 점수는 중재군에서 사전 14.47 ± 2.30 점에서 사후 15.61 ± 1.88 점으로 증가하여, 실제 평균 변화량은 1.14점이었고, 보정된 평균 변화량이 1.29 ± 0.23 점으로 나타났으며, 이는 대조군의 변화량(0.33 ± 0.23 점)보다 0.96점 더 큰 변화였다($P = 0.006$). 이러한 결과는 참여자가 인식하는 식품 구매 및 이용의 용이성과 가정 내 식품 구비 수준이 개선되었음을 의미한다. 사회적 지지 점수는 중재군에서 사전 6.56 ± 1.22 점에서 사후 7.26 ± 1.32 점으로 증가하여, 실제 평균 변화량은 0.70점이었고, 보정된 평균 변화량이 0.71 ± 0.17 점으로 나타났으며, 이는 대조군의 변화량(0.06 ± 0.17 점)보다 0.65점 더 큰 변화였다($P = 0.011$). 이러한 결과는 건강한 식생활과 관련하여 가족·친구와의 대화와 관심 등 대인적 지지에 대한 인식이 향상되었음을 보여준다. 환경적 요인 총점은 중재군에서 사전 21.03 ± 2.88 점에서 사후 22.86 ± 2.60 점으로 증가하여, 실제 평균 변화량은 1.83점이었고, 보정된 평균 변화량이 2.00 ± 0.28 점으로 나타났으며, 이는 대조군의 변

Table 2. Changes in cognitive factors related to dietary behavior after the nutrition intervention

Variables/group	Pre	Post	Adjusted change ([post-pre] $\pm$ SE ¹⁾)	P-value ²⁾
Dietary knowledge total score				< 0.001
Intervention (n = 66)	10.03 $\pm$ 1.99	12.67 $\pm$ 1.24	2.80 $\pm$ 0.19	
Control (n = 65)	9.11 $\pm$ 2.13	10.14 $\pm$ 2.01	0.87 $\pm$ 0.19	
Outcome expectation total score				0.018
Intervention (n = 66)	20.68 $\pm$ 2.61	21.86 $\pm$ 2.49	1.54 $\pm$ 0.39	
Control (n = 65)	20.09 $\pm$ 2.65	20.60 $\pm$ 2.36	0.14 $\pm$ 0.39	
Value expectation total score				0.194
Intervention (n = 66)	22.45 $\pm$ 2.16	22.59 $\pm$ 2.31	0.66 $\pm$ 0.30	
Control (n = 65)	21.05 $\pm$ 2.26	21.63 $\pm$ 2.53	0.06 $\pm$ 0.31	
Self-efficacy total score				< 0.001
Intervention (n = 66)	22.12 $\pm$ 2.60	24.33 $\pm$ 2.75	2.33 $\pm$ 0.36	
Control (n = 65)	22.42 $\pm$ 2.97	22.86 $\pm$ 2.81	0.33 $\pm$ 0.36	

Mean $\pm$ SD.

Dietary knowledge scores ranged from 0 to 14, with 1 point assigned for each correct response. Outcome and value expectations ranged from 5 to 25, and self-efficacy ranged from 6 to 30. Higher scores indicate greater dietary knowledge, more positive expectations, and higher self-efficacy. SE, standard error.

¹⁾Adjusted mean differences (post-pre) were estimated using analysis of covariance (ANCOVA), adjusted for age, family type, education level, baseline dietary knowledge, and baseline value expectations.

²⁾P-values indicate differences between the intervention and control groups after adjustment.

Table 3. Changes in environmental factors related to dietary behavior after the nutrition intervention

Variables/group	Pre	Post	Adjusted change ([post-pre] $\pm$ SE ¹)	P-value ²
Food accessibility/availability				0.006
Intervention (n = 66)	14.47 $\pm$ 2.30	15.61 $\pm$ 1.88	1.29 $\pm$ 0.23	
Control (n = 65)	13.88 $\pm$ 2.36	14.35 $\pm$ 2.39	0.33 $\pm$ 0.23	
Social support				0.011
Intervention (n = 66)	6.56 $\pm$ 1.22	7.26 $\pm$ 1.32	0.71 $\pm$ 0.17	
Control (n = 65)	6.60 $\pm$ 1.47	6.68 $\pm$ 1.29	0.06 $\pm$ 0.17	
Environmental factors total score				< 0.001
Intervention (n = 66)	21.03 $\pm$ 2.88	22.86 $\pm$ 2.60	2.00 $\pm$ 0.28	
Control (n = 65)	20.48 $\pm$ 2.91	21.03 $\pm$ 3.03	0.39 $\pm$ 0.29	

Mean $\pm$ SD.

Food accessibility/availability scores ranged from 4 to 20, social support scores ranged from 2 to 10, and total environmental factor scores ranged from 6 to 30. Higher scores indicate more favorable environmental conditions.

SE, standard error.

¹Adjusted mean differences (post-pre) were estimated using analysis of covariance (ANCOVA), adjusted for age, family type, education level, baseline dietary knowledge, and baseline value expectations.

²P-values indicate differences between the intervention and control groups after adjustment.

화랑(0.39 $\pm$ 0.29점)보다 1.61점 더 큰 변화였다($P < 0.001$). 전반적으로 식품 접근성 및 가정 내 식품 가용성, 사회적 지지, 환경적 요인 총점에서 중재군의 증가폭이 더 크게 나타났다. 전반적으로 본 중재는 노인의 식생활 실천을 둘러싼 지지적 환경에 대한 인식에 긍정적인 변화를 가져온 것으로 보인다.

4. 행동변화단계의 변화

행동변화단계의 전후 분포 변화는 Fig. 2에 제시하였다. 중재군과 대조군 모두에서 단계 분포의 변화 양상이 관찰되었다. 중재군에서는 중재 전 행동 단계가 6명(9.1%), 준비단계가 44명(66.7%), 고려 전·고려 단계가 16명(24.2%)이었으나, 중재 후에는 각각 62명(93.9%), 4명(6.1%), 0명(0.0%)으로 변화하였다. 즉, 행동 단계 비율은 84.8%p 증가하였고, 준비단계와 고려 전·고려 단계 비율은 각각 60.6%p와 24.2%p 감소하였다. 특히 준비단계 대상자 44명 중 41명(93.2%), 고려 전·고려 단계 대상자 16명 중 15명(93.8%)이 행동 단계로 이동하여, 중재 후 대부분의 참여자가 실제 실천 단계에 도달한 것으로 나타났다. 다만 중재군에서는 사후 고려 전·고려 단계의 빈도가 0으로 나타나 McNemar-Bowker 검정통계량이 산출되지 않았으므로, 집단 내 전후 변화는 교차표와 분포 변화 양상을 중심으로 제시하였다.

대조군에서도 행동변화단계의 전후 분포는 유의하게 변화하였다(McNemar-Bowker test, $\chi^2(3) = 23.333$, $P < 0.001$). 대조군의 행동 단계는 중재 전 10명(15.4%)에서 중재 후 33명(50.8%)으로 증가하였고, 준비단계는 41명(63.1%)에서 19명(29.2%)으로 감소하였다. 즉, 행동 단계 비율은 35.4%p 증가하였고, 준비단계 비율은 33.9%p 감소하였다. 그러나 이러한 변화의 폭은 중재군에 비해 작았다.

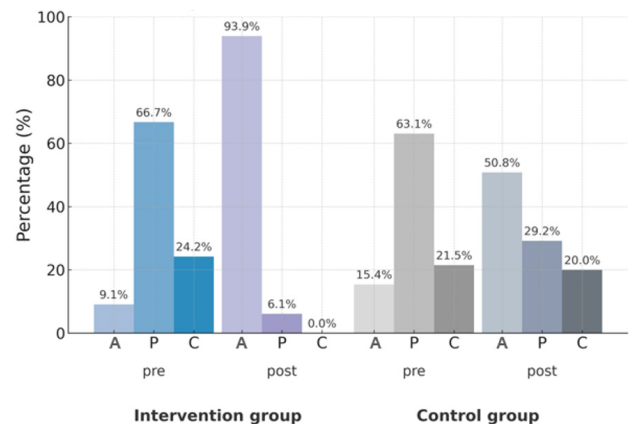


Fig. 2. Changes in stages of dietary behavior change before and after the intervention in the intervention (n = 66) and control groups (n = 65). Behavioral stages were reclassified into three categories: precontemplation/contemplation (C), preparation (P), and action (A). The figure presents the distributional change in behavioral stages before and after the intervention in each group. Within-group pre-post changes in stage distribution were examined using cross-tabulation, and the McNemar-Bowker test was applied when the reclassified distribution formed a square table. Between-group differences in post-intervention stage distribution were compared using the chi-square test, and the consistency of the result was additionally confirmed using the Fisher-Freeman-Halton exact test.

사후 행동변화단계 분포는 두 군 간 유의한 차이를 보였다($\chi^2 = 31.629$, $P < 0.001$). 추가로 실시한 Fisher-Freeman-Halton

exact test에서도 동일하게 유의한 결과가 확인되었다($P < 0.001$). 이러한 결과는 본 중재가 단순한 인식 변화에 그치지 않고, 식생활 실천 단계로의 전환과 관련되었을 가능성을 시사한다.

5. 식행동 결과 지표의 변화

식행동 결과 지표(NQ-E)의 변화는 Table 4에 제시하였다. NQ-E의 하위 영역(균형, 절제, 실천)과 총점을 분석한 결과, 균형 영역 점수는 중재군에서 사전 60.51 ± 13.47 점에서 사후 65.78 ± 13.68 점으로 증가하여, 실제 평균 변화량은 5.27점이었고, 보정된 평균 변화량이 5.68 ± 1.89 점으로 나타났으며, 이는 대조군의 변화량(-1.54 ± 1.91 점)보다 7.22점 더 큰 변화였다($P = 0.013$). 이러한 결과는 균형 잡힌 식사 구성과 관련된 식행동이 개선되었음을 의미한다. 실천 영역 점수는 중재군에서 사전 66.61 ± 12.54 점에서 사후 71.15 ± 12.54 점으로 증가하여, 실제 평균 변화량은 4.54점이었고, 보정된 평균 변화량이 4.53 ± 1.24 점으로 나타났으며, 이는 대조군의 변화량(0.77 ± 1.25 점)보다 3.76점 더 큰 변화였다($P = 0.047$). 이는 교육 내용을 일상생활 속 식행동으로 적용하려는 실천 수준이 향상된 것으로 볼 수 있다. 반면 절제 영역 점수는 중재군과 대조군 모두 사전 대비 증가하였으나, 집단 간 보정된 변화량의 차이는 통계적으로 유의하지 않았다($P = 0.412$). NQ-E 총점은 중재군에서 사전 63.18 ± 10.58 점에서 사후 68.54 ± 10.53 점으로 증가하여, 실제 평균 변화량은 5.36점이었고, 보정된 평균 변화량이 5.25 ± 1.24 점으로 나타났으며, 이는 대조군의 변화량(0.40

± 1.25 점)보다 4.85점 더 큰 변화였다($P = 0.011$). 전반적으로 NQ-E의 균형, 실천 및 총점에서 중재군의 변화폭이 더 크게 나타났다.

6. 프로그램 만족도 평가

프로그램 만족도 평가는 Table 5에 제시하였다. 중재군을 대상으로 평가한 프로그램 만족도는 평균 4.69 ± 0.41 점으로 매우 높게 나타났다. 프로그램의 회차별 주제에 대한 교육 참여 관심도와 교육 후 실제 도움 정도를 비교 분석한 결과, '개인별 영양상담', '규칙적이고 균형 잡힌 식단 구성법', '저작·연하 기능 저하 예방과 관리법' 항목에서 교육 후 실제 도움 정도가 사전 관심도에 비해 유의하게 높았다($P = 0.001$). 주제별 분석 결과, 대상자들은 프로그램 전반에 대해 높은 도움 정도를 인식하였으며, 특히 일상생활에 직접 적용 가능한 실천 중심 주제에서 교육 전 관심보다 교육 후 도움 정도를 더 높게 평가하였다. 한편 '안전한 식품 구매와 보관법', '건강에 도움이 되는 식품 선택' 항목은 사전부터 높은 관심도를 보였으며, 교육 후에도 도움 정도가 높게 유지되었다.

DISCUSSION

본 연구는 SCT의 개인적·환경적 구성요소와 TTM에 기반하여 설계한 7주 영양중재 프로그램이 지역사회 노인의 개인적·환경적 요인, 행동변화단계, 식행동 결과 지표에 미치는 영향을 평

Table 4. Changes in NQ-E index by subdomains after the nutrition intervention

Variables/group	Pre	Post	Adjusted change ([post-pre] $\pm$ SE ¹⁾)	P-value ²⁾
Balance domain				0.013
Intervention (n = 66)	60.51 $\pm$ 13.47	65.78 $\pm$ 13.68	5.68 $\pm$ 1.89	
Control (n = 65)	61.00 $\pm$ 15.98	59.87 $\pm$ 17.01	-1.54 $\pm$ 1.91	
Moderation domain				0.412
Intervention (n = 66)	65.96 $\pm$ 31.18	74.76 $\pm$ 28.06	5.44 $\pm$ 3.57	
Control (n = 65)	59.64 $\pm$ 30.99	66.12 $\pm$ 30.37	9.89 $\pm$ 3.60	
Practice domain				0.047
Intervention (n = 66)	66.61 $\pm$ 12.54	71.15 $\pm$ 12.54	4.53 $\pm$ 1.24	
Control (n=65)	65.32 $\pm$ 13.94	66.08 $\pm$ 13.39	0.77 $\pm$ 1.25	
NQ-E total score				0.011
Intervention (n = 66)	63.18 $\pm$ 10.58	68.54 $\pm$ 10.53	5.25 $\pm$ 1.24	
Control (n = 65)	62.37 $\pm$ 12.27	62.66 $\pm$ 12.12	0.40 $\pm$ 1.25	

Mean $\pm$ SD.

NQ-E domain and total scores were calculated using the official scoring system and converted to a 0–100 scale. Higher scores indicate more favorable dietary behavior outcomes.

NQ-E, Nutrition Quotient for the Elderly; SE, standard error.

¹⁾Adjusted mean differences (post–pre) were estimated using analysis of covariance (ANCOVA), adjusted for age, family type, education level, baseline dietary knowledge, and baseline value expectations.

²⁾P-values indicate differences between the intervention and control groups after adjustment.

Table 5. Comparison of pre-program interest and post-program perceived helpfulness (n = 66)

Topics	Pre-program interest	Post-program helpfulness	P-value ¹⁾
Individual nutrition counseling	4.15 ± 0.68	4.64 ± 0.48	0.001
Meal planning for regular and balanced diets	4.08 ± 0.77	4.45 ± 0.56	0.001
Prevention and management of chewing and swallowing difficulties	3.95 ± 0.79	4.29 ± 0.65	0.001
Safe food purchasing and storage practices	4.24 ± 0.66	4.48 ± 0.56	0.015
Selection of foods beneficial for health	4.36 ± 0.60	4.52 ± 0.53	0.105

Mean ± SD.

Scores were rated on a 5-point Likert scale, with higher scores indicating greater interest or perceived helpfulness.

¹⁾P-values were obtained using paired t-tests.

가하였다. 집단 간 인구사회학적 편차와 사전 수준 차이를 공변량으로 보정한 분석에서, 중재군은 대조군과 비교하여 식생활 지식, 결과기대, 자아효능감, 환경적 요인, 행동변화단계, 식행동 결과 지표인 NQ-E에서 유의한 개선을 보였다. 이러한 결과는 SCT의 개인적·환경적 구성요소를 중심으로 설계된 맞춤형 영양중재가 단순한 정보 제공을 넘어 실제 식생활 실천과 관련된 다양한 요인에 긍정적인 변화를 가져올 수 있음을 시사한다. 본 연구에서 TTM은 개별 목표를 각각 별도 결과변수로 측정하는 틀이 아니라, 단계별 맞춤 상담 전략을 적용하기 위한 실천적 틀로 활용되었으며, 그 효과 평가는 행동변화단계의 상향 이동과 식행동 결과 지표의 변화를 통해 확인하였다.

먼저 식생활 지식은 중재군에서 유의하게 향상되었으며, 이는 집단 영양교육을 통해 노인의 식생활 지식 수준이 개선되었음을 보고한 국내 중재 연구 결과와 일치한다[13, 23]. 특히 Shin 등[13]은 노인복지관 이용 노인을 대상으로 한 집단 교육 중심 영양중재에서 식생활 지식의 유의한 향상을 보고한 바 있으며, Seo [23]의 연구에서도 SCT에 기반한 교육 프로그램 적용 후 지식 점수의 개선이 확인되었다. 본 연구에서 관찰된 지식 향상은 단순한 정보 습득에 그치지 않고, 이후 결과기대와 자아효능감의 변화와 함께 나타났다는 점에서 실제 식생활 실천을 위한 인지적 준비가 강화되었을 가능성을 보여준다. 다만 일부 문항은 사전 정답률이 높아 변화 폭이 제한적이었는데, 이는 문항 특성에 따른 천장효과 가능성을 시사한다. 향후 교육 설계에서는 기초 내용의 반복 노출을 최소화하고 적용·실천 중심 과제와 점점 도구를 결합하여 학습의 유지와 일반화를 강화할 필요가 있다. 대조군에서는 일회성 교육 후 특정 개념의 지식은 일부 향상되었으나, 결과기대와 자아효능감의 변화가 제한적이었던 점에서 지식 단독 개입의 한계를 시사한다.

결과기대와 자아효능감은 중재군에서 유의하게 증가하였다. SCT 관점에서 결과기대와 자아효능감은 건강행동 수행을 촉진하는 핵심 인지 요인으로 제시되어 왔다[16-18]. 건강한 식생활 실천의 긍정적 효과에 대한 인식과 실천 자신감이 함께 향상된 것은, 본 프로그램이 노인의 식생활 관련 인지적 준비 수준을 높였음을 보여준다. 이러한 변화는 개인별 영양상담, 목표 설

정, 실천 과제 제시, 반복적 피드백이 단순한 정보 제공을 넘어 행동 실천에 대한 자신감을 강화하는 데 기여했을 가능성을 시사한다. 또한 자아효능감 증진을 중심으로 한 노인 영양중재가 영양상태 지표 개선과 연결될 수 있음을 보고한 최근 연구와도 맥락을 같이한다[26].

반면 가치기대는 사전부터 높은 수준을 유지하여 유의한 변화가 관찰되지 않았다. 이는 가치기대가 단기 중재를 통해 크게 변화하기보다는, 건강과 식생활에 대한 개인의 신념이나 우선 순위와 관련된 비교적 안정적인 동기 요인일 가능성을 시사한다. 또한 본 연구 대상자가 지역사회 노인시설을 자발적으로 이용하고 프로그램 참여 의지를 가진 집단이라는 점에서, 사전부터 건강한 식생활의 중요성에 대한 인식 수준이 상대적으로 높았을 가능성도 고려할 수 있다. 따라서 후속 연구에서는 가치기대의 변동과 지속성을 장기적으로 추적하고, 가치기대 수준에 따라 실천 기술 및 환경적 지지 요소를 차별적으로 구성하는 접근을 검토할 필요가 있다.

둘째, 환경적 요인에서도 중재군의 유의한 개선이 확인되었다. 특히 식품 접근성 및 가정 내 식품 가용성, 사회적 지지, 환경적 요인 총점의 향상은 건강한 식생활과 관련된 식품 구매 및 이용의 용이성, 가정 내 식품 구비 수준, 그리고 주변의 도움과 지지에 대한 인식이 함께 개선되었음을 보여주며, 노인의 식생활 실천이 개인의 의지뿐 아니라 지지적 환경과도 밀접하게 관련됨을 시사한다. SCT는 행동이 개인 요인, 환경 요인, 행동 수행 간의 상호작용 속에서 형성된다고 설명하는데[16-18], 본 연구 결과는 이러한 이론적 틀이 노인 대상 영양중재에서도 적용 가능함을 뒷받침한다. 본 연구에서 사회적 지지는 가족·친구의 관심과 식생활 관련 대화 등 대인적 지지에 대한 인식을 반영한다는 점에서, 교육과 개인별 상담은 이러한 지지 자원을 보다 잘 인식하고 활용하도록 돕는 역할을 했을 가능성이 있다. 또한 식품 접근성 및 가정 내 식품 가용성은 객관적인 지역 식품환경 자체의 변화보다는 참여자가 인식하는 식품 구매 및 이용의 용이성과 가정 내 건강한 식품 구비 수준을 반영한 지표라는 점에서, 본 중재가 식생활 실천을 위한 생활환경을 보다 긍정적으로 인식하고 활용하도록 도왔을 가능성을 시사한다. 이는 교육 중

심 개입만으로는 식품 구매 환경이나 이동성 등 구조적 접근성의 변화가 제한적이었음을 보고한 선행 연구와 다소 다른 양상으로, 본 연구에서는 개인별 상담과 목표 점검이 병행되면서 참여자의 지각된 환경 수준까지 함께 개선되었을 가능성을 보여준다[26]. Baek 등[27]의 연구에서도 주부를 대상으로 한 SCT 기반 저염 교육 프로그램 적용 후 지식 및 자아효능감은 향상되었으나, 실제 식환경과 관련된 행동 변화는 제한적으로 나타난 바 있다. 또한 식품안정성이 낮은 노인일수록 영양섭취 수준과 건강지표가 더 취약하다고 보고한 Maeng 등[10]의 연구 결과를 고려할 때, 향후 노인 영양증대에서는 교육·상담 중심 접근을 넘어 지역사회 식품 지원, 배달 서비스, 이동 지원 등 지역사회 자원 연계를 포함한 다층적 지원 전략을 병행할 필요가 있다.

셋째, 행동변화단계 분석에서 중재군의 행동 단계 비율이 크게 증가한 것은 본 프로그램의 최종 목표였던 단계별 맞춤 목표 설정과 실천이 실제 식행동 실천으로의 전환과 관련된 가능성을 보여준다. 이는 교육, 상담, 환경적 지지 요소를 통합한 복합 영양증대가 가장 효과적이라고 보고한 해외 체계적 문헌고찰 연구와도 일치하는 결과이다[28]. 다만 본 연구에서는 행동변화 단계를 초기 5단계로 조사하였으나, 유지단계를 포함한 일부 범주의 사례 수가 매우 적어 분석 시 고려 전·고려, 준비, 행동의 3단계로 재분류하였다. 따라서 본 연구에서 관찰된 변화는 장기적인 유지 단계 진입을 의미하기보다, 중재 직후 행동 단계로의 단기적 상향 이동으로 해석하는 것이 적절하다. 다시 말해, 본 연구 결과는 행동 변화의 시작 가능성을 보여주는 근거로는 의미가 있으나, 그 변화가 장기적으로 지속되는지 여부까지 확인한 것은 아니다. 따라서 후속 연구에서 중·장기 추적과 재강화 전략의 효과를 검증할 필요가 있다. 마지막으로, 본 연구는 7주간 집합교육과 개인별 상담을 결합한 중·장기 프로그램임에도 높은 참여도와 만족도를 보였다. 특히 개인별 영양상담과 균형 식단 구성, 저작·연하 관리, 식품 안전 교육 주제에서 도움 인식이 높았다는 점은 향후 프로그램 기획 시 대상자의 요구도와 실행 가능성을 함께 반영할 필요가 있음을 시사한다. 주제별 분석에서도 대상자들은 프로그램 전반에 대해 높은 도움도를 인식하였으며, 특히 일상생활에 직접 적용 가능한 실천 중심 주제에서 교육 전 관심보다 교육 후 도움 정도를 더 높게 평가하였다. 이러한 결과는 본 프로그램이 이론적 타당성뿐 아니라 실제 현장 적용 가능성 측면에서도 실용적인 중재 모델이 될 수 있음을 시사한다.

넷째, 식행동 결과 지표로 평가한 NQ-E는 중재군에서 총점과 하위 영역 중 균형 및 실천 영역의 점수가 유의하게 향상되었다. NQ-E는 SCT의 행동적 구성요인을 직접 측정한 지표라기보다, 중재 후 실제 식행동 수준의 변화를 반영하는 결과 지표라는 점에서, 본 연구 결과는 행동변화단계의 상향 이동과 함께 개인적·환경적 변화가 실제 식행동 수준의 개선으로 이어졌을 가능성을 보여주는 것으로 해석할 수 있다. 이는 NQ-E의 기

준 값과 전국 노인의 분포 수준을 제시한 Lim 등[25]의 연구와 비교할 때, 본 연구 중재군의 사후 점수가 평균 수준을 상회하는 범위로 개선되었음을 의미한다. 또한 지역사회 노인을 대상으로 중재 없이 관찰된 NQ-E 수준을 보고한 선행 연구들[29, 30]에서는 균형 및 실천 영역 점수가 상대적으로 낮거나 취약한 것으로 보고된 바 있는데, 이에 비해 본 연구에서는 해당 영역에서 유의한 개선이 확인되었다. 특히 균형 영역의 향상은 균형 잡힌 식사 구성과 관련된 식행동의 개선, 실천 영역의 향상은 교육 내용을 일상생활 속 식행동으로 적용하려는 수준이 높아졌음을 의미한다. 따라서 NQ-E의 향상은 SCT의 행동적 요인이 직접 개선되었다기보다, SCT의 개인적·환경적 구성요소를 중심으로 한 중재가 행동변화단계의 상향 이동과 실제 식행동 결과의 개선으로 이어졌을 가능성을 보여주는 결과로 해석하는 것이 적절하다. 다만 절제 영역은 사전 점수가 비교적 높아 변화 폭이 제한적이었으며, 이는 천장효과에 따른 결과일 가능성을 고려할 필요가 있다.

Limitations

본 연구는 비동등성 대조군 전·후 유사실험 설계를 적용하여 무작위 배정이 이루어지지 않았다는 한계가 있다. 이에 따라 연령, 학력, 가족구성, 사전 식생활 지식 및 가치기대와 같은 관찰 가능한 집단 차이는 ANCOVA를 통해 보정하였으나, 건강 동기나 인지 기능과 같이 측정되지 않은 요인의 불균형까지는 완전히 통제하지 못했을 가능성이 있다. 또한 본 연구의 주요 프로그램 효과는 공변량을 보정한 ANCOVA를 통해 중재군과 대조군 간 차이로 평가하였으나, 연구대상자가 시설 단위로 배정되었음에도 분석은 개인 수준에서 수행되었다. 이로 인해 동일 시설 내 참여자들의 응답이 서로 독립적이지 않았을 가능성이 있으며, 군집 효과를 반영하지 않은 개인 단위 분석은 시설 내 상관관을 무시함으로써 표준오차를 과소 추정하고 신뢰구간을 좁히며, 결과적으로 통계적 유의성을 실제보다 크게 평가했을 가능성이 있다. 따라서 본 연구에서 관찰된 중재 효과의 크기와 유의성은 실제보다 과대 추정되었을 가능성을 배제할 수 없으며, 결과 해석 시 신중한 접근이 필요하다. 다만 본 연구에 포함된 시설 수가 7개로 제한되어 있어, 군집 수준 분산을 안정적으로 추정하는 추가 분석을 수행하기에는 한계가 있었다. 향후 연구에서는 더 많은 시설을 포함한 군집설계 또는 다층모형을 적용하여 군집 효과를 고려한 중재 효과를 검증할 필요가 있다. 또한 주요 평가지표가 자기보고식 설문에 기반하고 있어 사회적 바람직성이나 회상 오류로 인한 응답 편향의 가능성을 배제할 수 없다. 더불어 본 연구는 SCT의 개인적 요인과 환경적 요인을 중심으로 중재를 설계하고 평가하였으나, 행동적 구성요인을 독립된 구성개념으로 측정하지 못하였다. 따라서 본 연구 결과를 SCT 전체를 포괄적으로 검증한 것으로 해석하는 데에는 제한이 있으며, SCT의 개인적·환경적 구성요소를 중심으로 한 실

천적 적용의 가능성을 보여주는 결과로 이해할 필요가 있다. 중재군은 집단교육과 함께 반복적인 개인별 상담 및 피드백을 제공받았으므로, 관찰된 변화는 이론 기반 영양중재의 효과를 반영하는 것으로 해석할 수 있으나, 대조군과 비교하여 접촉 빈도와 중재 강도에 차이가 있었던 만큼 반복적 접촉에 따른 영향이 일부 포함되었을 가능성 역시 완전히 배제할 수 없다. 아울러 연구대상자는 서울 및 경기 지역의 서로 다른 노인시설에서 모집되었으며, 대부분은 노인종합복지관이었고 1개 기관은 천주교 운영 시니어 아카데미였다. 본 연구에서는 주요 기초 특성은 공변량으로 보정하였으나, 시설 유형과 지역 특성 자체를 별도의 변수로 통제하지 못하였으므로 이에 따른 영향이 결과에 일부 반영되었을 가능성을 배제할 수 없다. 또한 연구대상자의 대부분이 여성으로 구성되어 있어 연구 결과의 일반화에는 제한이 있을 수 있다. 더불어 중재 종료 후 장기 추적조사가 이루어지지 않아 행동 변화와 행동변화단계의 지속성을 확인하지 못한 점도 본 연구의 한계이다. 향후 연구에서는 무작위 대조 설계와 장기 추적조사를 적용하여 프로그램의 인과성과 지속 효과를 검증하고, 혈압이나 신체 계측과 같은 객관적 지표를 병행 측정함으로써 자기보고식 평가의 한계를 보완할 필요가 있다.

Conclusion

본 연구는 SCT의 개인적·환경적 구성요소와 TTM을 통합한 7주간의 영양중재 프로그램이 지역사회 노인의 개인적·환경적 요인, 행동변화단계, 식행동 결과 지표(NQ-E)의 긍정적 변화와 관련됨을 확인하였다. 특히 식생활 지식, 결과기대, 자아효능감의 향상과 환경적 지지의 강화가 행동변화단계의 상향 이동과 실제 식행동 개선과 관련될 수 있다는 점에서 본 연구의 의의가 있다. 또한 집단교육과 개인별 영양상담을 결합한 중재는 높은 참여도와 만족도를 바탕으로 지역사회 노인을 위한 실천 중심 영양중재 모델의 적용 가능성을 제시하였다. 이러한 결과는 SCT의 개인적·환경적 구성요소를 중심으로 설계된 맞춤형·실천 중심 영양중재가 지역사회 노인의 식생활 개선과 행동 변화 촉진에 유용한 접근이 될 수 있음을 시사하며, 향후 지역사회 노인 영양관리 및 건강증진 프로그램 개발의 근거 자료로 활용될 수 있을 것이다.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Research Article

대구·경북지역 대학생들의 지속가능한 식생활에 대한 인지도와 중요도 및 수행도

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Awareness, importance and performance of sustainable diets among university students in Daegu and Gyeongbuk, Korea: a cross- sectional study

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Objectives: The need for a sustainable diet is being emphasized as dietary changes are linked to climate change, biodiversity loss, and worsening food security. The purpose of this study was to investigate university students' awareness, knowledge, behaviors, perceived importance, and performance of sustainable diets, and to compare these variables between students who had taken a food and nutrition course and those who had not.

Methods: A total of 300 university students in the Daegu Gyeongbuk region, Korea, participated in an online survey conducted in 2024, and 292 valid (male, 139; female, 153) responses were analyzed. The survey assessed awareness, knowledge, behaviors, perceived importance, and performance of sustainable diets. These were compared between participants (134) and non-participants (158) in the food and nutrition course.

Results: Our results showed that 54.5% of students were aware of sustainable diets, and 58.7% expressed an intention to participate in sustainable diet education in the future. The total knowledge and behavior scores on sustainable diets were 7.09/10 and 3.67/5, respectively, and the scores of the course-taking group were significantly higher than those of the non-course-taking group. The actual level of performance of sustainable diets (3.63/5) was relatively low compared to their perceived importance (3.93/5). Students who took the course demonstrated significantly higher importance (society) and performance (environment, health, and society) scores than those who did not. No significant differences were detected between the two groups regarding the importance of the environmental and health aspects of sustainable diets.

Conclusion: Students taking the food and nutrition course demonstrated high levels of awareness, knowledge, behavior, perceived importance, and performance regarding sustainable diets. These findings highlight the need for systematic educational strategies in

higher education to promote sustainable dietary competencies among university students.

Keywords: awareness; knowledge; behavior; universities; diet

INTRODUCTION

지속가능한 식생활(sustainable diets)은 단순한 영양 중심의 식이 권고를 넘어, 식품의 생산·유통·소비·폐기 전 과정에서 환경적·사회적 지속가능성을 고려해야 한다는 문제의식 속에서 등장하였다. 이러한 개념은 1986년 Gussow & Clancy [1]가 기존 식이지침에 환경적 한계를 통합해야 한다고 주장하면서 최초로 제안되었다. 2000년대 들어 유엔식량농업기구(Food and Agriculture Organization of the United Nations, FAO)를 중심으로 푸드시스템 전 과정이 환경·자원·건강에 미치는 영향을 본격적으로 논의하기 시작하였으며, 2010년 FAO는 지속가능한 식생활을 건강, 환경, 사회·문화·경제적 요소를 포함한 다차원적 개념으로 정의하였다[2]. 또한 지속가능한 식생활의 핵심 요소를 웰빙과 건강, 생물다양성·환경·기후, 공평성·공정무역, 친환경·지역농산물·제철식품, 문화유산·기술, 식품과 영양소 요구·식품보장·접근성의 6개 영역으로 제시하며, 이러한 요소를 통합적으로 충족하는 식생활을 지향해야 함을 강조하였다[3].

2019년 World Health Organization (WHO)와 FAO의 「Sustainable healthy diets: guiding principles」 발표를 통해 지속가능한 식생활은 글로벌 정책 의제로 자리 잡았다[4]. 또한 EAT-Lancet Commission [5]은 식생활 변화가 기후변화, 생물다양성 감소, 식량안보 악화와 직접적으로 연결된다는 근거를 제시하며 지속가능한 식생활로의 전환의 필요성을 강조하였다.

우리나라는 2009년 농림축산식품부의 식생활교육지원법 제정 이후 2010년부터 5년마다 식생활교육 기본계획을 수립하며 지속가능한 식생활을 국가 식생활 정책의 핵심 방향으로 설정하였다[6, 7]. 특히 제3차 기본계획(2020–2024)에서는 지속가능한 식생활을 건강(영양) 차원을 넘어 농업·환경·사회 등 다양한 사회적 가치의 실현에 기여하는 개념으로 확장하였다[6]. 이에 따라 국내에서는 농업·농촌 자원과 전통 식문화를 반영한 체험 중심의 식생활교육이 확대되었다. 농촌융복합산업 기반 식생활교육[8], 식생활교육지원센터와 국민네트워크의 범국민 활동[9], 지역 농산물 및 전통 식문화 기반 교육[10], 학교 텃밭 체험 교육 프로그램 개발[11] 등은 이러한 변화의 대표적 예이다. 또한 국외 사례에서도 지속가능한 식생활교육은 영양교육을 넘어 환경·사회·경제를 포함하는 체험 기반 교육으로 발전하고 있다[12].

대학생들은 코로나19 이후 배달음식, 가정간편식뿐 아니라 야식 섭취가 증가되었고, 자취·기숙사 생활과 제한된 경제력으

로 인하여 균형 잡힌 식품을 선택하기 보다는 고열량 편의식을 선택함에 따라 비만 등 생활습관병의 위험에 노출되고 있다[13–17]. 대학생 대상 지속가능한 식생활에 대한 인식 및 실태 조사 연구[18]에 따르면, 지속가능한 식생활 수준이 높은 집단은 대체육에 대한 인식 및 구입 의향은 높았으나 육류 소비 실태는 차이가 없는 것으로 나타났다. 또한 대학생들의 친환경 의식과 지속가능발전에 대한 인식은 녹색소비행동에 유의한 영향을 미치는 것으로 나타났고[19], 대학생들은 지속가능한 식생활을 건강·환경 중심으로 이해하는 경향이 강하며, 사회·경제적 측면에 대한 이해도는 낮은 것으로 나타났다[20].

유엔은 국제사회가 함께 달성해야 할 지속가능발전목표(Sustainable Development Goals, SDGs) 17가지를 제시하였으며, 이 중 목표 2에서 기아 해결(zero hunger), 목표 12에서 책임감 있는 소비와 생산(responsible consumption and production)을 명시하였고[21], 유네스코는 SDGs 달성을 위한 지속가능발전교육(Education for Sustainable Development) 2030의 이행을 강조하였다[22]. 이러한 글로벌 흐름은 생산·가공·유통·소비·폐기로 이어지는 푸드시스템 전 과정이 환경과 사회에 미치는 영향이 매우 크다는 점을 보여주며, 지속가능한 식생활 역량 함양의 필요성을 강조한다. 그러나 국내 지속가능한 식생활교육 자료와 프로그램은 유아·초중등학생 대상이 대부분[8–11, 23–25]이며, 대학생 대상 자료는 매우 부족한 실정이고, 대학 교육 현장에서 지속가능한 식생활을 체계적으로 다루는 교과목 또한 드문 상황이다[26].

따라서 본 연구에서는 대구·경북 지역 대학생을 대상으로 지속가능한 식생활에 대한 인지도, 지식, 행동 수준, 중요도와 수행도를 조사하고, 식품·영양 강좌 수강 여부에 따른 차이를 분석하여, 향후 대학 교육에서의 지속가능한 식생활 역량 강화를 위한 교육적 시사점을 도출하고자 하였다.

METHODS

Ethics statement

The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of Kyungpook National University (approval number: KNU 2024-0452).

1. 연구설계

본 연구는 대구·경북지역 대학생들의 지속가능한 식생활에 대한 인지도와 중요도 및 수행도를 분석하기 위한 횡단연구(cross-sectional study)이며, STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) 보고 지침(<https://www.strobe-statement.org/>)을 준수하여 기술하였다.

2. 연구 대상 및 기간

본 연구의 대상자 수는 G*power를 통해 산출된 300명으로 하였으며, 설문지는 2023년 12월, 대학생 20명을 대상으로 예비조사를 거쳐 문항의 이해도, 난이도 등을 고려하여 수정·보완하였다. 본 조사는 2024년 1월 5일부터 1월 25일까지 대구·경북 지역 소재 3개 대학교에 재학중인 대학생 300명을 대상으로 온라인 설문조사를 실시하였고, 불충분 응답 8부를 제외한 292부(남학생 139명, 여학생 153명)를 분석에 활용하였다.

3. 일반사항

연구대상자의 일반사항은 성별, 나이, 전공계열(식품계열, 비식품계열), 식품·영양 강좌 수강 여부, 주거 형태, 동반식사 여부, 신장 및 체중의 총 7개 문항을 조사하였다. 체질량지수(body mass index, BMI)는 대한비만학회[27]의 비만기준에 따라 $< 18.5 \text{ kg/m}^2$ 저체중, $18.5\text{--}22.9 \text{ kg/m}^2$ 정상체중, $23.0\text{--}24.9 \text{ kg/m}^2$ 과체중, $\geq 25 \text{ kg/m}^2$ 비만으로 판정하였다.

4. 지속가능한 식생활에 대한 인지도 및 지식 조사

지속가능한 식생활에 대한 인지도 설문 문항은 Kim [20]의 연구를 참고하여 지속가능한 식생활에 대한 인지도, 인지 경로, 교육 참여 의사 등 총 3문항으로 구성하였다. 지속가능한 식생활에 대한 지식 문항은 「제3차 식생활교육 기본계획」[6]의 내용을 기반으로 총 10문항을 개발하였으며, 정답은 1점, 오답은 0점으로 하여 10점 만점으로 평가하였다.

5. 지속가능한 식생활 행동 및 중요도와 수행도 조사

지속가능한 식생활 행동 문항은 FAO가 제시한 지속가능한 식생활 6개 요소[3]를 근거로 환경, 건강, 사회의 3개 영역으로 구분하여 총 20문항을 개발하였다. 즉 환경·기후·생물다양성, 친환경·지역농산물·제철식품의 두 요소를 묶어서 환경으로, 웰빙·건강, 식품과 영양소 요구·식품보장·접근성 두 요소를 묶어서 건강으로, 공평성·공정무역, 문화유산·기술을 묶어서 사회영역으로 재분류하였다. 지속가능한 식생활 행동 문항점수는 리커트 5점 척도를 사용하여 산출하였다.

지속가능한 식생활에 대한 중요도와 수행도 문항은 「제3차 식생활교육 기본계획」[6]에서 제시한 건강, 환경, 사회(배려) 핵심요소를 얼마나 중요하게 생각하고 수행하는지를 확인하기 위하여 환경 6문항, 건강 2문항, 사회 2문항의 총 10문항을 개발하였으며, 모든 문항은 리커트 5점 척도를 활용하여 점수를

산출하였다.

6. 통계분석

모든 자료는 IBM SPSS Statistics 30 (IBM Co.) 프로그램을 사용하여 통계처리 및 분석하였으며, 모든 통계적 유의성은 $P < 0.05$ 의 수준에서 실시하였다. 성별에 따른 인구통계학적 특성과 지속가능한 식생활에 대한 인지도는 빈도수(백분율)와 평균 $\pm$ 표준편차로 제시하였으며, 성별에 따른 차이는 교차분석과 t-test로 검증하였다. 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 인지도는 빈도수(백분율)로 제시하였으며, 교차분석으로 차이를 검증하였다. 또한 지속가능한 식생활 관련 지식, 행동, 중요도와 수행도는 평균 $\pm$ 표준편차로 제시하였으며, 이들 변수의 식품·영양 강좌 수강 여부에 따른 차이는 성별을 공변량으로 하여 공분산분석으로 검증하였다. 지속가능한 식생활 관련 중요도와 수행도 간 비교는 t-test로 검증하였으며, 중요도와 수행도의 차이를 확인하기 위하여 importance-performance analysis 도표를 작성하였다. 또한 각 변수들에 대한 신뢰도를 분석한 결과 Cronbach 알파값이 지속가능한 식생활 관련 지식은 0.663, 행동은 0.947, 중요도는 0.902, 수행도는 0.918로 각각 나타났다.

RESULTS

1. 일반사항

연구 대상 대학생들의 일반사항은 Table 1과 같으며, 남자 139명(47.6%), 여자 153명(52.4%)이었고, 나이는 전체 평균 22.1세였다. BMI는 전체 평균 21.9 kg/m^2 이었으며, 남자(23.7 kg/m^2)가 여자(20.2 kg/m^2)보다 유의하게 높았고($P < 0.001$), 정상 집단이 가장 많았으나(59.6%), 과체중 이상의 비율은 남학생(64.7%)이 여학생(7.2%)에 비해 높은 것으로 나타났다($P < 0.001$). 비식품 계열 학생 비율(82.5%)이 더 높았고($P < 0.001$), 식품·영양 강좌를 수강한 적이 없는 학생 비율(54.1%)이 더 높았으며($P < 0.001$), 성별 식품·영양 강좌 수강 여부에서 남학생은 수강하지 않은 경우가, 여학생은 수강 경험이 있는 경우가 많아 성별 간 유의한 차이가 있었다($P < 0.001$). 주거 형태는 자택이 가장 많았고(59.2%), 자취(27.7%), 기숙사(11.3%) 순으로 나타났다.

2. 지속가능한 식생활에 대한 성별 및 식품·영양 강좌 수강 여부에 따른 인지도 비교

대학생들의 지속가능한 식생활에 대한 인지도를 분석한 결과는 Table 2와 같다. 지속가능한 식생활에 대하여 ‘조금 알고 있다’와 ‘잘 알고 있다’가 54.5%였고, ‘들어본 적 있으나 잘 모른다’가 32.9%였다. 알고 있는 비율은 여학생(57.5%)이 남학생(51.0%)보다 높았고($P < 0.01$), 식품·영양 강좌 수강집단(68.7%)이 미수강집단(42.4%)보다 높았다($P < 0.001$).

Table 1. Demographic characteristics of the participants

Variable	Total (n = 292)	Male (n = 139)	Female (n = 153)	P-value ¹⁾
Age (year)	22.1 ± 1.95	22.5 ± 2.13	21.8 ± 1.72	0.005
Body mass index (kg/m ²)	21.9 ± 2.39	23.7 ± 1.70	20.2 ± 1.58	< 0.001
Underweight	17 (5.8)	0 (0.0)	17 (11.1)	< 0.001
Normal	174 (59.6)	49 (35.3)	125 (81.7)	
Overweight	68 (23.3)	57 (41.0)	11 (7.2)	
Obesity	33 (11.3)	33 (23.7)	0 (0.0)	
Major				< 0.001
Food related major	51 (17.5)	17 (12.2)	34 (22.2)	
Non-food related major	241 (82.5)	122 (87.8)	119 (77.8)	
Food and nutrition courses				< 0.001
Attended	134 (45.9)	48 (34.5)	86 (56.2)	
Not attended	158 (54.1)	91 (65.5)	67 (43.8)	
Residence type				0.592
Home	173 (59.2)	77 (55.4)	96 (62.7)	
Living alone	81 (27.7)	41 (29.5)	40 (26.1)	
Dormitory	33 (11.3)	18 (12.9)	15 (9.8)	
Other	5 (1.7)	3 (2.2)	2 (1.3)	

n (%) or Mean ± SD.

¹⁾P-value is calculated by t-test or chi-square test.**Table 2.** Comparison of awareness of sustainable diets by sex and food and nutrition course attendance among the participants

Variable	Total (n = 292)	Male (n = 139)	Female (n = 153)	P-value	Attended (n = 134)	Not attended (n = 158)	P-value ¹⁾
Awareness of sustainable diet				0.006			< 0.001
Never heard of it	37 (12.7)	12 (8.6)	25 (16.3)		9 (6.7)	28 (17.7)	
Heard of it but don't know well	96 (32.9)	56 (40.3)	40 (26.1)		33 (24.6)	63 (39.9)	
Know a little	141 (48.3)	59 (42.4)	82 (53.6)		80 (59.7)	61 (38.6)	
Know well	18 (6.2)	12 (8.6)	6 (3.9)		12 (9.0)	6 (3.8)	
Pathway to learning about sustainable diet				0.003			< 0.001
Never heard of it	37 (12.7)	12 (8.6)	25 (16.3)		9 (6.7)	28 (17.7)	
School	94 (32.2)	40 (28.8)	54 (35.3)		64 (47.8)	30 (19.0)	
Mass media	146 (50.0)	83 (59.7)	63 (41.2)		54 (40.3)	92 (58.2)	
Family	14 (4.8)	3 (2.2)	11 (7.2)		7 (5.2)	7 (4.4)	
Others	1 (0.3)	1 (0.7)	0 (0.0)		0 (0.0)	1 (0.6)	
Willingness to participate in sustainable diet education				0.001			< 0.001
Not at all	2 (0.7)	2 (1.4)	0 (0.0)		0 (0.0)	2 (1.3)	
Not willing	23 (7.9)	15 (10.8)	8 (5.2)		2 (1.5)	21 (13.3)	
Neutral	94 (32.2)	54 (38.8)	40 (26.1)		30 (22.4)	64 (40.5)	
Willing	139 (47.6)	60 (43.2)	79 (51.6)		78 (58.2)	61 (38.6)	
Strongly willing	34 (11.6)	8 (5.8)	26 (17.0)		24 (17.9)	10 (6.3)	

n (%).

¹⁾P-value is calculated by chi-square test.

알게 된 경로는 전체적으로 대중매체가 50.0%로 가장 많았고, 학교(32.2%), 가족(4.8%) 순이었다. 식품·영양 강좌 수강집단은 학교(47.8%), 대중매체(40.3%), 들어본 적 없음(6.7%), 가족(5.2%) 순이었으며, 미수강집단의 경우 대중매체가 58.2%로 가장 높았고, 학교(19%), 들어본 적 없음(17.7%), 가족(4.4%) 순으로 수강 여부에 따른 차이가 있었다($P < 0.001$). 향후 지속가

능한 식생활 교육 참여 의사는 '그렇다(47.6%)', '매우 그렇다(11.6%)'를 합하면 59.2%로 나타났다. 또한 여학생(68.6%)이 남학생(49.0%)보다($P = 0.001$), 수강집단(76.1%)이 미수강집단(44.9%)보다($P < 0.001$) 참여 의사가 높은 것으로 나타났다.

Table 3. Comparison of knowledge of sustainable diets by food and nutrition course attendance among the participants

Questions	Total (n = 292)	Attended (n = 134)	Not attended (n = 158)	P-value ¹⁾
Climate change from global warming does not affect food production	0.83 ± 0.37	0.84 ± 0.36	0.82 ± 0.38	0.618
Lower food mileage increases the carbon footprint	0.35 ± 0.47	0.47 ± 0.50	0.25 ± 0.43	< 0.001
Food waste cannot be recycled	0.72 ± 0.44	0.84 ± 0.36	0.62 ± 0.48	< 0.001
Vegetarian and plant-based meats use fewer resources and emit less greenhouse gas than livestock farming	0.79 ± 0.40	0.87 ± 0.33	0.73 ± 0.44	0.007
Vegetarian and plant-based meats are not related to reducing over-fishing and marine pollution from aquaculture	0.76 ± 0.42	0.86 ± 0.34	0.67 ± 0.47	< 0.001
Vegetarian diets and plant-based meats are separate from the ethical issues of traditional animal farming	0.63 ± 0.48	0.69 ± 0.46	0.58 ± 0.49	0.047
Vegetarian diets have a larger carbon footprint compared to meat-based diets	0.47 ± 0.50	0.50 ± 0.50	0.44 ± 0.49	0.343
Plant-based meats address global food issues by efficiently providing protein	0.84 ± 0.35	0.88 ± 0.31	0.81 ± 0.38	0.168
Vegetarian diets produce more waste and packaging compared to meat-based diets	0.88 ± 0.31	0.89 ± 0.30	0.87 ± 0.32	0.744
Vegetarian diets benefit local communities and promote sustainable agricultural practices	0.78 ± 0.41	0.78 ± 0.41	0.77 ± 0.41	0.652
Total ²⁾	7.09 ± 2.11	7.65 ± 2.01	6.62 ± 2.07	< 0.001

Mean ± SD.

¹⁾P-value is calculated by ANCOVA, the analysis of covariance adjusted for sex.²⁾Total score 10 points.

3. 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 지식 비교

대학생들의 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 지식 비교 결과는 Table 3과 같다. 지속가능한 식생활에 대한 지식 문항의 총점은 7.09점/10점이었으며, 수강집단(7.65점)이 미수강집단(6.62점) 보다 점수가 높았다($P < 0.001$).

수강집단이 미수강집단보다 지식 점수가 높았던 문항은 ‘푸드 마일리지가 낮을수록 탄소발자국은 증가한다’ ($P < 0.001$), ‘음식물 쓰레기는 재활용되지 않는다’ ($P < 0.001$), ‘채식 식단과 대체육은 과도한 어획과 양식으로 인한 해양오염을 줄이지 않는다’ ($P < 0.001$)의 세 문항이었다. 점수가 가장 높았던 문항은 ‘채식은 고기 위주의 식단에 비해 폐기물과 포장에 많다’였고(0.88점/1점), 점수가 가장 낮았던 문항은 ‘푸드 마일리지가 낮을수록 탄소발자국은 증가한다’였다(0.35점/1점).

4. 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활 행동 비교

대학생들의 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활 행동 비교 결과는 Table 4와 같다. 지속가능한 식생활에 대한 행동 문항의 전체 평균은 3.67점/5점이었고, 식품·영양 강좌 수강집단(3.85점)은 미수강집단(3.52점)보다 점수가 유의하게 높았다($P < 0.001$). 세부 영역별 점수는 환경 영역(3.70점), 건강 영역(3.67점), 사회 영역(3.62점) 순이었고, 세 영역 모두 식품·영양 강좌 수강집단의 행동점수가 미수강집단에 비하여 유의하

게 높았다(각각 $P < 0.001$).

전체 문항을 비교해 볼 때 환경 영역의 ‘음식물 쓰레기가 발생하지 않도록 먹을 만큼만 조리한다’가 4.03점으로 가장 높았고, 환경 영역의 ‘텃밭 가꾸기에 참여하거나 집에서 채소와 과일을 재배한다’가 3.37점으로 가장 낮았다.

수강집단이 미수강집단에 비하여 점수가 특히 높았던 문항은 환경 영역의 ‘가능한 동물 유래 성분이 포함된 제품 구입은 피한다’ ($P < 0.001$)와 건강 영역의 ‘식품을 선택할 때 알레르기과 민감성을 고려한다’ ($P < 0.001$), ‘식품을 선택할 때 식품표시를 확인한다’ ($P < 0.001$), ‘외식할 때 비건식당이나 비건 옵션을 찾는다’ ($P < 0.01$) 문항이었다.

5. 지속가능한 식생활에 대한 중요도와 수행도 비교

대학생들의 지속가능한 식생활에 대한 중요도와 수행도 점수를 비교한 결과는 Table 5와 같다. 전체 평균 점수에서 중요도가 3.93점/5점으로 수행도(3.63점/5점)보다 점수가 높았으며($P < 0.001$), 거의 모든 문항에서 중요도가 수행도 보다 높았다(각각 $P < 0.001$).

영역별 평균 점수를 비교했을 때 중요도와 수행도 모두 건강 영역이 각각 4.02점, 3.78점으로 가장 높았고, 다음으로 환경 영역이 각각 3.95점, 3.65점이었으며, 사회 영역이 3.78점, 3.42점이었다.

중요도에서 가장 점수가 높은 문항은 환경 영역 중 ‘음식물 쓰레기 감량을 위해 노력한다’, ‘식재료의 국내산(지역산) 여부

Table 4. Comparison of behaviors related to sustainable diets by food and nutrition course attendance among the participants

Area	Questions ²⁾	Total (n = 292)	Attended (n = 134)	Not attended (n = 158)	P-value ¹⁾
Environment	Use reusable items (shopping bags, tumblers, etc.) instead of disposable ones	3.85 ± 0.90	3.97 ± 0.85	3.75 ± 0.93	0.126
	Cook only as much as you can eat to avoid food waste	4.03 ± 0.78	4.11 ± 0.70	3.96 ± 0.84	0.267
	Use energy-efficient appliances when cooking	3.85 ± 0.90	4.05 ± 0.84	3.68 ± 0.92	0.003
	Avoid purchasing products containing animal-derived ingredients whenever possible	3.54 ± 1.09	3.82 ± 1.00	3.30 ± 1.11	< 0.001
	Participate in vegetarian challenges like “Meatless Monday” to reduce meat consumption	3.46 ± 1.21	3.65 ± 1.17	3.31 ± 1.23	0.020
	Try to consume various types of plant-based meats regularly	3.62 ± 1.02	3.80 ± 1.02	3.47 ± 1.01	0.008
	Choose vegetarian snacks and plant-based milk alternatives	3.67 ± 1.02	3.86 ± 1.00	3.50 ± 1.01	0.003
	Participate in gardening or grow vegetables and fruits at home	3.37 ± 1.29	3.55 ± 1.22	3.22 ± 1.33	0.062
	Choose eco-friendly products (pesticide-free, organic, etc.) when buying agricultural products	3.74 ± 0.97	3.89 ± 0.90	3.61 ± 1.02	0.030
	Buy domestic agricultural products over imported ones considering food mileage	3.87 ± 0.96	4.05 ± 0.84	3.71 ± 1.02	0.006
	Average	3.70 ± 0.71	3.88 ± 0.69	3.55 ± 0.70	< 0.001
Health	Consider allergies and sensitivities when choosing foods	3.70 ± 1.05	4.03 ± 0.83	3.41 ± 1.12	< 0.001
	Check food labels (expiration date, ingredients, nutrient, etc.) when selecting foods	3.88 ± 0.96	4.14 ± 0.76	3.67 ± 1.06	< 0.001
	Read food labels to check for additives, allergens, and nutrients when choosing plant-based meats	3.68 ± 1.06	3.76 ± 1.01	3.62 ± 1.09	0.304
	Plan vegetarian meals to meet nutritional needs	3.68 ± 1.04	3.88 ± 1.02	3.51 ± 1.03	0.003
	Look for vegan restaurants or options when eating out	3.42 ± 1.08	3.67 ± 1.03	3.22 ± 1.09	< 0.001
	Average	3.67 ± 0.80	3.89 ± 0.69	3.48 ± 0.84	< 0.001
Society	Check for fair trade certification when buying coffee, chocolate, tea, etc.	3.44 ± 1.25	3.63 ± 1.11	3.29 ± 1.34	0.029
	Show interest in food donation activities to help the socially disadvantaged	3.59 ± 0.99	3.71 ± 1.02	3.50 ± 0.96	0.140
	Choose products from companies that support animal welfare (free-range animal products, etc.)	3.50 ± 0.93	3.62 ± 0.93	3.39 ± 0.92	0.121
	Interest in local specialties and traditional foods	3.80 ± 0.98	3.94 ± 0.99	3.69 ± 0.96	0.078
	Share information about plant-based meats and vegetarian diets with others	3.78 ± 0.99	3.96 ± 1.02	3.63 ± 0.94	0.007
	Average	3.62 ± 0.83	3.77 ± 0.87	3.50 ± 0.78	0.016
Total average		3.67 ± 0.73	3.85 ± 0.70	3.52 ± 0.72	< 0.001

Mean ± SD.

¹⁾P-value is calculated by ANCOVA, the analysis of covariance adjusted for gender.²⁾Each item was scored on a 5-point Likert scale (1–5).

에 관심을 가진다’로 모두 4.08점이었다. 수행도에서는 환경 영역의 ‘음식물 쓰레기 감량을 위해 노력한다’와 건강 영역의 ‘가정식·급식·외식 시 신선한 채소를 선택한다’가 3.85점으로 가장 높았다.

중요도와 수행도를 분석한 결과는 Fig. 1과 같다. 중요도와 수행도가 모두 높은 문항은 ‘음식물 쓰레기 감량을 위해 노력한다’, ‘가정식·급식·외식 시 신선한 채소를 선택한다’, ‘식재료의 국내산 여부에 관심을 가진다’, ‘비만과 만성질환을 예방할 수 있는 식생활을 한다’, ‘지역 내 특산물이나 먹거리에 관심을 가

진다’로 나타났다. 중요도는 높으나 수행도가 낮은 문항은 ‘환경에 대한 피해를 최소화하는 식품을 선택하고 소비한다’였다. 나머지 4문항은 중요도와 수행도가 모두 낮게 나타났으며, 중요도는 낮으나 수행도는 높은 문항은 없었다.

6. 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 중요도 비교

식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 중요도 점수를 비교한 결과는 Table 6과 같다. 전체 중요도 점수는

Table 5. Comparison of the perceived importance and performance of sustainable diets among the participants

Area	Questions ²⁾	Importance (n = 292)	Performance (n = 292)	P-value ¹⁾
Environment	Strive to reduce food waste	4.08 ± 0.83	3.85 ± 0.87	0.001
	Choose and consume foods that minimize environmental harm	3.97 ± 0.97	3.60 ± 0.99	< 0.001
	Check for low carbon certification when purchasing food	3.79 ± 0.98	3.47 ± 1.04	< 0.001
	Interest in whether the ingredients are domestic (local)	4.08 ± 0.78	3.72 ± 0.91	< 0.001
	Interest in local specialties and food	3.96 ± 0.93	3.65 ± 0.99	< 0.001
	Prioritize purchasing local agricultural products through local food direct stores	3.85 ± 0.99	3.61 ± 1.07	0.006
	Average	3.95 ± 0.68	3.65 ± 0.77	< 0.001
Health	Maintain a diet to prevent obesity and chronic diseases (hypertension, diabetes, cardiovascular diseases, etc.)	4.00 ± 1.01	3.72 ± 1.01	0.001
	Choose fresh vegetables with meals at home, in cafeterias, or dining out, etc	4.05 ± 0.82	3.85 ± 0.96	0.008
	Average	4.02 ± 0.73	3.78 ± 0.86	< 0.001
Society	Share information about sustainable diets with others	3.83 ± 0.96	3.49 ± 1.11	< 0.001
	Interest in regional dietary experiences involving citizens and institutions	3.74 ± 0.99	3.35 ± 1.07	< 0.001
	Average	3.78 ± 0.88	3.42 ± 0.99	< 0.001
Total average		3.93 ± 0.68	3.63 ± 0.76	< 0.001

Mean ± SD.

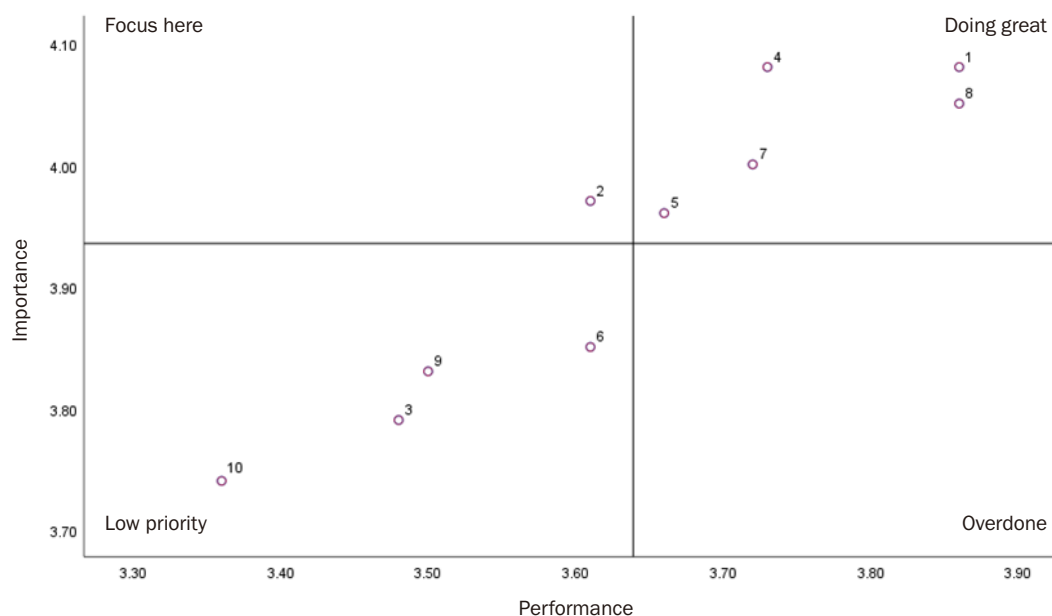
¹⁾P-value is calculated by ANCOVA, the analysis of covariance adjusted for gender.²⁾Each item was scored on a 5-point Likert scale (1–5).

Fig. 1. Importance-performance analysis of sustainable diets. 1, strive to reduce food waste; 2, choose and consume foods that minimize environmental harm; 3, check for low carbon certification when purchasing food; 4, interest in whether the ingredients are domestic (local); 5, interest in local specialties and food; 6, prioritize purchasing local agricultural products through local food direct stores; 7, maintain a diet to prevent obesity and chronic diseases; 8, choose fresh vegetables with meals at home, in cafeterias, or dining out, etc.; 9, share information about sustainable diets with others; 10, interest in regional dietary experiences involving citizens and institutions.

Table 6. Comparison of the perceived importance of sustainable diets by food and nutrition course attendance among the participants

Area	Questions ²⁾	Attended (n = 134)	Not attended (n = 158)	P-value ¹⁾
Environment	Strive to reduce food waste	4.20 ± 0.66	3.98 ± 0.94	0.063
	Choose and consume foods that minimize environmental harm	4.08 ± 0.91	3.87 ± 1.02	0.109
	Check for low carbon certification when purchasing food	3.86 ± 0.91	3.73 ± 1.04	0.241
	Interest in whether the ingredients are domestic (local)	4.20 ± 0.65	3.96 ± 0.86	0.022
	Interest in local specialties and food	3.97 ± 0.95	3.94 ± 0.91	0.903
	Prioritize purchasing local agricultural products through local food direct stores	3.89 ± 1.01	3.80 ± 0.98	0.529
	Average	4.03 ± 0.65	3.88 ± 0.71	0.111
Health	Maintain a diet to prevent obesity and chronic diseases (hypertension, diabetes, cardiovascular diseases, etc.)	4.00 ± 1.03	3.99 ± 0.99	0.709
	Choose fresh vegetables with meals at home, in cafeterias, or dining out, etc	4.17 ± 0.61	3.94 ± 0.95	0.024
	Average	4.08 ± 0.66	3.96 ± 0.78	0.315
Society	Share information about sustainable diets with others	3.92 ± 0.96	3.74 ± 0.95	0.129
	Interest in regional dietary experiences involving citizens and institutions	3.86 ± 0.96	3.62 ± 1.00	0.079
	Average	3.89 ± 0.90	3.68 ± 0.85	0.070
Total average		4.01 ± 0.65	3.86 ± 0.69	0.109

Mean ± SD.

¹⁾P-value is calculated by ANCOVA, the analysis of covariance adjusted for gender.²⁾Each item was scored on a 5-point Likert scale (1–5).

수강집단이 4.01점, 미수강집단이 3.86점이었으나 수강 여부에 따른 유의한 차이는 없었다.

문항별로는 ‘식재료가 국산(지역산)인지에 관심을 갖는다’ ($P < 0.05$), ‘가정식·급식·외식 시 신선한 채소를 선택한다’ ($P < 0.05$) 문항에서 수강집단이 미수강집단에 비해 중요도 점수가 높았다.

7. 식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 수행도 비교

식품·영양 강좌 수강 여부에 따른 지속가능한 식생활에 대한 수행도 점수를 비교한 결과는 Table 7과 같다. 수강집단(3.86점)이 미수강집단(3.44점)에 비해 수행도 전체 점수($P < 0.001$)가 높았으며, 환경($P < 0.001$), 건강($P < 0.05$), 사회($P < 0.001$) 세 영역 점수도 수강집단의 수행도 점수가 유의하게 높았다.

문항별로는 환경 영역의 모든 문항과 건강 영역에서는 ‘가정식·급식·외식 시 신선한 채소를 선택한다’ ($P < 0.01$) 문항에서, 사회 영역에서는 ‘지속가능한 식단에 관한 정보를 다른 사람들과 공유한다’ ($P < 0.001$), ‘시민과 기관이 함께하는 지역 식생활 체험 활동에 관심을 갖는다’ ($P < 0.001$) 문항에서 수강 집단의 수행도 점수가 유의하게 높았다. 다만 건강 영역의 ‘비만과 만성질환 예방을 위한 식사를 유지한다’는 문항에서는 식품·영양 강좌 수강 여부에 따른 수행도에 차이가 없었다.

DISCUSSION

본 연구는 대구·경북 지역 대학생을 대상으로 지속가능한 식생활에 대한 인지도, 지식, 행동, 중요도 및 수행도를 분석하고, 특히 식품·영양 강좌 수강 여부에 따른 차이를 확인하였다. 그 결과 전체 대학생의 54.5%가 지속가능한 식생활을 인지하고 있었으나, 실제 실천 수준은 인식에 비해 낮아 인지-행동 간 간극이 뚜렷하게 나타났다. 이러한 경향은 국내 선행연구[18] 뿐 아니라 국외 연구에서도 일관되게 보고되고 있다. 예를 들어 WHO·FAO는 지속가능한 식생활에 대한 인지도가 높더라도 행동으로 전환되기까지 다양한 장애요인이 존재한다고 설명하였으며[4], Sahadeo 등[28] 역시 남아프리카 대학생을 대상으로 한 연구에서 인지·태도는 긍정적이지만 실제 행동은 낮은 수준임을 확인하였다.

대학생의 지속가능한 식생활에 대한 인지 경로는 대중매체가 50.3%로 가장 높았으며, 이는 학생들이 학교교육보다 미디어에서 더 많은 정보를 얻고 있음을 의미한다. 국외 연구에서도 유사한 패턴이 나타났는데, Arrazat 등[29]은 캐나다 대학생을 대상으로 한 연구에서 건강·환경친화적 식습관 실천의 핵심 결정요인이 ‘지식’ 그 자체보다 ‘실천 여건(환경·가격·접근성)’임을 밝힌 바 있다. 즉 정보 노출과 교육 기회가 실천 행동을 결정하는 데 중요한 기반이라는 것이다. 국내에서는 ‘지속가능한 식생활’ 개념이 정책적으로 구체화된 시기가 비교적 최근이며[6], 실제 대학 교과과정에서 관련 강좌와 교재가 부족하다[26]. 미국

Table 7. Comparison of performance on sustainable diets by food and nutrition course attendance among the participants

Area	Questions ²⁾	Attended (n = 134)	Not attended (n = 158)	P-value ¹⁾
Environment	Strive to reduce food waste	4.04 ± 0.75	3.70 ± 0.93	0.002
	Choose and consume foods that minimize environmental harm	3.85 ± 0.88	3.40 ± 1.03	< 0.001
	Check for low carbon certification when purchasing food	3.74 ± 1.02	3.25 ± 1.00	< 0.001
	Interest in whether the ingredients are domestic (local)	3.96 ± 0.80	3.54 ± 0.96	< 0.001
	Interest in local specialties and food	3.86 ± 0.99	3.49 ± 0.98	0.005
	Prioritize purchasing local agricultural products through local food direct stores	3.87 ± 1.08	3.40 ± 1.02	< 0.001
	Average	3.88 ± 0.72	3.46 ± 0.76	< 0.001
Health	Maintain a diet to prevent obesity and chronic diseases (hypertension, diabetes, cardiovascular diseases, etc.)	3.82 ± 0.99	3.64 ± 1.03	0.165
	Choose fresh vegetables with meals at home, in cafeterias, or dining out, etc.	4.03 ± 0.77	3.71 ± 1.08	0.007
	Average	3.92 ± 0.76	3.67 ± 0.92	0.019
Society	Share information about sustainable diets with others	3.80 ± 1.09	3.24 ± 1.07	< 0.001
	Interest in regional dietary experiences involving citizens and institutions	3.72 ± 1.05	3.06 ± 1.01	< 0.001
	Average	3.75 ± 0.98	3.14 ± 0.91	< 0.001
Total average		3.86 ± 0.73	3.44 ± 0.74	< 0.001

Mean ± SD.

¹⁾P-value is calculated by ANCOVA, the analysis of covariance adjusted for gender.²⁾Each item was scored on a 5-point Likert scale (1–5).

[30, 31]의 경우 대학에서 지속가능한 식생활 교육을 실시한 사례도 있고, 2025년에는 미국[32]에서 학부생을 대상으로 하는 환경과 지속가능성에 관한 식품시스템 교육과정이 개발되었다. 우리나라에서는 2022 초·중등 교육과정을 개정하면서 지속가능한 식생활교육의 핵심 가치인 환경, 건강, 배려 요소가 반영되었다. 향후 대학에서도 다학제간 연구를 통해서 지속가능한 식생활을 교육할 수 있도록 교육과정 개편이 이루어질 필요가 있다.

지속가능한 식생활 관련 지식 분석 결과, 본 연구에서 지속가능한 식생활 지식 점수는 식품·영양 강좌 수강 집단이 미수강 집단보다 높았다. 특히 ‘푸드 마일리지·탄소발자국’, ‘음식물 쓰레기 재활용’, ‘식물성 대체육의 환경적 효과’ 항목의 차이가 컸다. 이러한 특징은 스페인 보건전문가·대학생을 분석한 Irazusta-Garmendia 등[33]의 연구와도 일치하며, 지식 수준이 높을수록 친환경적 식품 선택 가능성이 증가함을 보여준다. 다만 지식이 행동으로 전환되는 비율은 제한적이라는 점도 선행연구[20]와 유사하다. 한편, 푸드 마일리지는 지속가능한 식생활에서 가장 기본적인 내용임에도 불구하고 수강집단에서도 낮은 점수(0.47점/1점)를 보였는데 이는 연구 대상자가 대부분 비전공자이면서 식품·영양 강좌 수강집단도 교양과목을 수강한 정도였기 때문인 것으로 사료된다. 따라서 교양과목이나 전공과목에서 푸드 마일리지 등 지속가능한 식생활의 실천을 유도할 수 있는 내용에 대한 교육을 강조할 필요가 있을 것이다.

지속가능한 식생활 행동 수준에서는 환경 영역 점수가 가장 높았고, 사회 영역 점수가 가장 낮았다. 특히 ‘텃밭 가꾸기’와

같은 체험 기반 실천 문항은 점수가 가장 낮았는데, 이는 공간·시간 제약, 실천 인프라 부족 등의 구조적 요인 때문으로 해석된다. 또한 대학생들은 학업 및 취업준비 등으로 바쁠 뿐 아니라 자취를 하거나 하숙을 하는 등의 여건으로 인해 이러한 체험 기반 실천문항의 점수가 낮은 것으로 사료된다. Mollaei 등[34]도 지속가능한 식생활 실천에는 자기효능감, 사회적 규범, 접근성 등이 중요하며, 교육만으로는 행동 변화를 완전히 설명하기 어렵다고 보고하였다. 또한 Arrazat 등[29]은 대학생의 건강·친환경 식생활 실천을 가로막는 장애요인으로 가격, 편의성, 습관을 제시하였고, 본 연구에서도 유사한 패턴이 나타났다.

지속가능한 식생활에 대한 모든 문항에서 중요도가 수행도보다 높음을 볼 때, 학생들은 지속가능한 식생활의 필요성을 충분히 인식하고 있음에도 불구하고 일상 실천에는 한계가 존재함을 보여준다. 이는 행동 결정 모델에서 태도·지식 외에도 환경적·제도적 요인이 큰 영향을 미친다는 국외 연구의 결론과도 맥락을 같이한다[28–30]. 대학생들은 지속가능한 식생활에서 건강과 환경에 대해서는 비교적 중요하게 생각하였으나 사회적 측면에 대해서는 중요성을 낮게 인식하는 것으로 나타났는데 이는 Kim [20]의 연구에서도 지적된 바 있다.

FAO에서 제시한 지속가능한 식생활 핵심 요소를 근거로 작성한 행동 문항과 국내 식생활교육 기본 계획의 핵심 가치를 기반으로 작성한 수행도 문항을 비교해 보면, 공통적으로 음식물 쓰레기 감량 행동과 식품 구매 시 국내산 여부에 관심을 가지는 문항에서 대학생들의 점수가 높은 것으로 나타났다. 이들 문항이 대학생 차원에서 실천하기에 비교적 적합한 문항인 것으로

사료된다.

종합적으로, 대구·경북 지역 대학생의 54.5%가 지속가능한 식생활을 인지하고 있었고, 향후 지속가능한 식생활 교육 참여 의사는 58.7%였다. 전체적으로 지속가능한 식생활에 대한 중요도는 높게 생각하였으나, 중요도에 비해 실제 수행 수준은 낮은 편이었다. 식품·영양 강좌를 수강한 학생들은 비수강 학생보다 지속가능한 식생활에 대한 인지도, 지식, 행동 및 수행도에서 모두 유의하게 높은 점수를 나타내 지속가능한 식생활 교육의 효과성을 확인할 수 있었다. 아울러 국외 연구들[29-34]이 공통적으로 제시하듯, 지속가능한 식생활 실천 향상을 위해서는 교육 제공, 실천 환경 조성(캠퍼스 텃밭·지역 식재료 활용·비건 옵션 확대 등), 사회적 규범 및 캠페인 강화가 함께 이루어져야 한다. 따라서 대학 차원의 교과목 운영, 실습·체험 프로그램 개발, 지역사회 연계 교육 등을 결합한 통합적 실천 지원 전략이 요구된다.

Limitations

본 연구는 대구와 경북 지역 소재 특정 대학의 대학생만을 대상으로 하였기에 표본의 지역적 제한이 있으며, 대표성이 부족하고, 자기보고식 설문 of 한계 및 결과의 일반화에 한계가 있다.

Conclusion

식품·영양 강좌 수강자들은 미수강자들에 비하여 지속가능한 식생활에 대한 인지도가 높았고, 지식, 행동 및 수행도가 높은 것으로 나타났다. 이는 대학생의 지속가능한 식생활 역량을 강화하기 위해서는 대학 교육 과정에서 지속가능한 식생활 교육을 체계적으로 포함해야 할 필요성을 강하게 시사한다.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

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DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

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Research Note

우리 국민의 당류 섭취 양상과 설탕 과다 사용 부담금

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Sugar intake from processed foods among Koreans and levy on excessive sugar use: a cross-sectional study

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Objectives: Although reduced mean sugar intakes have been reported recently, proportion changes in the Korean population with a sugar intake higher than the World Health Organization (WHO) sugar intake recommendation (WSIR) remain unknown. Therefore, in this study, we analyzed the sugar intake of Koreans to identify trends and prioritize target groups for relevant policy interventions.

Methods: We used dietary intake data from the 8th and 9th Korea National Health and Nutrition Examination Surveys (KNHANES VIII and IX) to derive sugar intake from processed foods (SIPF) in the Korean population. We classified, aggregated and calculated sugar intake from individual foods at the tertiary-level food codes, and assessed SIPF adequacy based on whether it met the WSIR of less than 10% of the total energy intake.

Results: The proportion of the Korean population with an SIPF exceeding the WSIR was 22.7% and 22.4% in KNHANES VIII and IX, respectively. Nevertheless, more than one-third of children, adolescents, and young adults (34.6%–39.1%) showed SIPF higher than the WSIR with the highest proportion of 41.4% registered among school-age girls in KNHANES IX.

Conclusion: While the mean sugar intake of Koreans has decreased slightly since 2019, the proportion of people with SIPF exceeding WSIR is on the rise in school-age children, adolescents, and young adults, implying the necessity of proactive policy responses. As the Korean government discusses fiscal policy design and implementation to moderate the sugar intake of the population in order to promote public health and prevent chronic diseases, it should bear in mind the point emphasized in the WHO guideline as follows: “Changes in health-related outcomes as a result of a fiscal policy are likely to occur in the long term and should therefore be evaluated over a longer term than outcomes such as purchasing and consumption of foods and beverages.”

Keywords: sugar intake; processed foods; WHO guideline; free sugars

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INTRODUCTION

최근 발표된 서울대학교 건강문화사업단의 설문조사 결과에 의하면, 우리 국민 대부분(80.1%)이 가당 음료 등을 생산하는 설탕 과다 사용 기업에 대해 설탕세를 물려야 한다고 응답했다고 한다[1]. 우리나라에는 1995년부터 공포·시행 중인 국민건강증진법이 존재하고, 동 법 제22조와 23조에는 국민건강증진사업의 원활한 추진에 필요한 재원을 확보하기 위하여 건강에 부담을 주는 요인에 대해 부담금을 부과할 근거가 포함되어 있으니, 그 비근한 예가 바로 담배에 부과되는 준조세 성격의 건강증진 부담금이다[2]. 이와 유사한 예는 다른 나라에서도 찾아볼 수 있는데, 2025년에 발간된 World Health Organization (WHO)의 보고서에 따르면 최근 국가나 주, 또는 도시 정부 차원에서 소위 ‘soda tax’의 도입이 급증해 2024년 7월 현재 최소 116개 국가에서 1가지 형태 이상의 가당 음료에 대해 소비세를 부과하고 있으며[3], 이는 WHO가 2015년에 발표한 “Guideline: sugars intake for adults and children” [4]에 이어 2022년과 2024년에 발표한 “WHO manual on sugar-sweetened beverage taxation policies to promote healthy diets” [5]와 “Fiscal policies to promote healthy diets: WHO guideline” [6]에 근거를 두고 있다.

당류 섭취에 대한 WHO 지침[4]에서는 건강한 식생활을 위해 전 생애주기에 걸쳐 아동과 성인 모두를 위해 유리당(free sugars)의 섭취를 총 에너지 섭취량의 10% 미만으로 감소시킬 것을 강력하게 권고하며, 이를 더 낮춰 5% 미만으로 유지하도록 하는 것은 근거의 확실성이 상대적으로 미흡함에 따라 조건부로 권고하였다.

여기에서 free sugars란 한국인 영양소 섭취기준[7]에 제시된 총당류와 구별되는 개념으로서, 그 근원은 1989년 영국

의 Committee on Medical Aspects of Food Policy (COMA)가 발간한 보고서 ‘Dietary sugars and human disease’이다[8]. COMA는 2000년 Scientific Advisory Committee on Nutrition이 설립되기 전까지 식품 및 영양 관련 사안에 대해 영국 정부에 자문을 제공했던 전문가위원회로서 당류 섭취 지침을 제시하면서 총당류를 다음과 같이 구분했다: 총당류는 intrinsic sugars (내재당)과 extrinsic sugars (외재당)로 구분되며, extrinsic sugars는 다시 milk sugars (유당)과 non-milk extrinsic sugars (NMES, 비우유성 외재당)로 구분된다. 이 NMES가 바로 WHO 지침[4]에서 말하는 free sugars로서 여기에는 첨가당과 꿀, 시럽, 과일 주스 등의 당류가 포함된다. 최근 European Food Safety Authority (EFSA)에서는 이를 보다 이해하기 쉽게 그림으로 정리하였다(Fig. 1) [9].

결국 보건 정책 차원에서 정부가 모니터링·평가·관리해야 하는 것은 free sugars 섭취량이지만 현재 가용한 화학적인 분석 방법으로는 식품에 포함된 첨가당이나 free sugars를 구분할 수 없다. 이러한 배경에서 질병관리청에서도 우리 국민의 당 섭취 현황을 총당류 기준으로 평가했으며[10], 우리나라의 가공식품 영양표시에는 총당류 함량 표시가 의무화되어 있지만, 미국의 영양표시에는 총당류와 함께 식품업체가 보고하는 첨가당의 양이 표시된다. 우리 식생활의 고질적인 문제였던 높은 나트륨 섭취량을 감소시킨 나트륨 저감 정책의 성공[11]에 이어, 2016년부터 ‘당류 저감 종합계획’을 수립·시행해 온 식품의약품안전처에서는 free sugars의 proxy indicator로 ‘가공식품에 기인하는 당류’를 사용해 우리 국민의 당류 섭취 실태를 모니터링하고 있다[12, 13]. 「식품의 기준 및 규격」에 명시된, “식품원료(농, 임, 축, 수산물 등)에 식품 또는 식품첨가물을 가하거나, 그 원형을 알아볼 수 없을 정도로 변형(분쇄, 절단 등)시키거나, 이와 같이

TOTAL SUGARS CAN BE DIVIDED INTO SUB-CATEGORIES

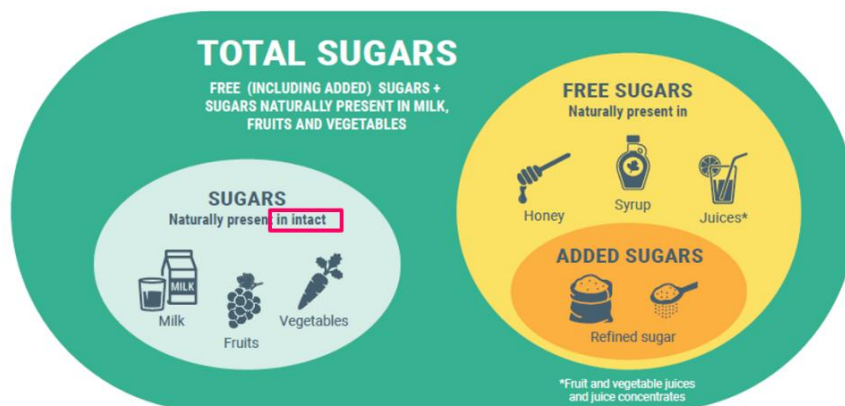


Fig. 1. Categorization of sugars. Adapted from EFSA Panel on Nutrition, Novel Foods and Food Allergens. (EFSA J 2022; 20(2): e07074) [9].

변형시킨 것을 서로 혼합 또는 이 혼합물에 식품 또는 식품첨가물을 사용하여 제조·가공·포장한 식품” (제1장 3.42) [14]이라는 가공식품의 정의와 함께, 가공 과정에서 식품원료의 세포 구조가 대부분 파괴된다는 점을 고려할 때, 가공식품에 기인하는 당류 섭취량을 free sugars 섭취량에 가장 가까운 대체 지표로 사용하는 것은 상당히 타당하다고 하겠다[15].

한편, 최근 발표된 질병관리청의 ‘주간 건강과 질병’ 제19권 제5호[16]에서는, ‘2016년부터 2023년까지 우리 국민의 총당 섭취량은 감소했지만 10-49세 국민의 경우, 음료와 차류를 통한 총당 섭취량의 비율이 높아 첨가당 함량이 높은 식품을 통한 당 섭취량 감소가 필요함’을 지적하며, 우리 국민의 당류 섭취량 관련 기준으로 총당류와 첨가당 섭취량이 제시된 ‘한국인 영양소 섭취기준’ [7]을 인용하였다. 이처럼 발표 주체 별로 각기 다른 지표를 사용해 우리 국민의 당류 섭취량과 섭취 양상을 분석하고 주로 평균값 위주로 결과를 발표함에 따라, 국민의 건강한 식생활 촉진을 위해 전 세계적으로 확산되고 있는 설탕세, soda tax, 또는 설탕 과다 사용 부담금이라 불리는 재정 정책의 도입을 위한 검토 근거로 이러한 내용만을 사용하기에는 미진한 부분이 있다. 이에, 본 연구에서는 2019년부터 가장 최근에 공개된 2024년까지의 국민건강영양조사 원시자료를 활용하여 우리 국민의 당류 섭취량 및 섭취 양상을 분석하고 그 결과를 동 조사의 기(期)별로 비교함으로써 변화 양상과 우선 정책 대상 집단을 찾아보고자 하였다.

METHODS

Ethics statement

Ethical review and approval were waived for this study due to the use of publicly available, de-identified data from the Korea National Health and Nutrition Examination Survey (KNHANES). The original survey protocols were previously approved by the Institutional Review Board of the Korea Disease Control and Prevention Agency (KDCA).

1. 연구설계

본 연구는 단면 연구로서, STROBE statement (<https://www.strobe-statement.org/>) 지침에 따라 기술하였다.

2. 우리 국민의 가공식품 기인 당류 섭취량 및 섭취 양상 분석

국민건강영양조사 제8기(2019-2021년)와 제9기(2022-2024년)의 원시자료 중 영양조사부문에서 24시간 회상법에 의해 조사된 식품섭취량조사 결과자료를 통합하여 분석하였다. 분석을 위한 기(期)별 원시자료 통합은 해당연도의 개인별 가중치를 1:1로 반영하여 이루어졌으며, 본 연구에 활용된 데이터의 대

상자 수는 각 연도별 표본 가구에 거주한 만 1세 이상의 국민 중 식품섭취량조사에 응답한 38,313명이었다.

우리 국민의 총당류 섭취량, 가공식품 기인 당류 섭취량, 당류 섭취량에 대한 주요 기여 식품, 당류 섭취 양상 등을 분석하기 위하여, 식품섭취량조사 결과 원시자료에 등장한 식품을 원재료성 식품(농·수·축산물 등), 과일류(주스를 제외한 과일), 우유류(원우유 및 분유 포함), 가공식품(원우유 및 분유 제외)으로 분류하였다[17]. 당류 섭취량은 동 원시자료에서 사용되는 3차 식품코드 수준으로 분류·집계·산출해 비교하였으며, 가공식품 기인 당류 섭취량의 적정성은 WHO의 당류 섭취 지침[4]에 제시된 ‘1일 에너지 섭취량에 대한 기여 비율 10% 미만’의 충족 여부로 평가하였다.

3. 통계분석

자료의 통계 처리에는 SAS 9.4 (SAS Institute)를 이용하였으며, 본 연구의 결과는 개인별 가중치와 집락추출변수(PSU) 및 분산추정변수(KSTRATA)를 적용하여 복합표본설계 분석방법(survey procedure)을 통해 산출되었다. 또한 가공식품 기인 당류 섭취량이 WHO의 당류 섭취 지침의 기준(에너지 기여 비율 10% 미만)을 초과하는 사람(이하 WHO 기준 초과자)의 비율에 대한 연도별 증감 추이를 검정하기 위하여, 미국 국립암연구소(National Cancer Institute, NCI)의 Joinpoint Regression Program을 이용하여 분석하였다[18]. 이때 산출된 연간 퍼센트 변화량(annual percent change, APC)은 절대 변화량이 아닌 전년도 대비 상대적 변화를 나타내며, APC의 통계적 유의수준은 t-검정을 통해 $P < 0.05$ 로 검정하였다.

RESULTS

우리 국민(1세 이상 전 연령층) 중 WHO 기준 초과자의 비율은 Fig. 2A에 보인 바와 같이 2019년부터 2024년까지 각각 22.8%, 22.7%, 22.7%, 22.6%, 22.9% 및 21.6%이었으며, 기(期)별로는 제8기와 제9기에 각각 22.7%와 22.4%로 나타났다. 이러한 결과는 우리 국민의 당류 섭취량이 최근 감소했다는 질병관리청의 보고[16]와 유사하지만, 연령층별로 비교(Fig. 2B)한 결과를 보면 대상 집단별로 양상이 조금 다른 것을 알 수 있다. WHO 기준 초과자 비율이 어린이와 청소년, 그리고 20대 청년층에서는 1/3을 넘었으며(34.6%-39.1%), 성·연령층별로 비교한 Fig. 2C와 Fig. 2D에서는 남자 청소년과 여자 어린이의 경우에 그 비율이 급격히 증가하여 제9기에 각각 33.0% (제8기 30.0%)와 41.4% (제8기 36.0%)에 달하는 것을 볼 수 있다.

이처럼 성·연령층별로 상이한 당류 섭취량 변화 양상은 Table 1에 제시된 총당류 섭취량과 가공식품 기인 당류 섭취량, 그리고 가공식품 기인 당류 섭취량의 에너지 비율에서도 드러나, 남자 청소년의 경우에 95th percentile에 해당되는 극단 섭취자

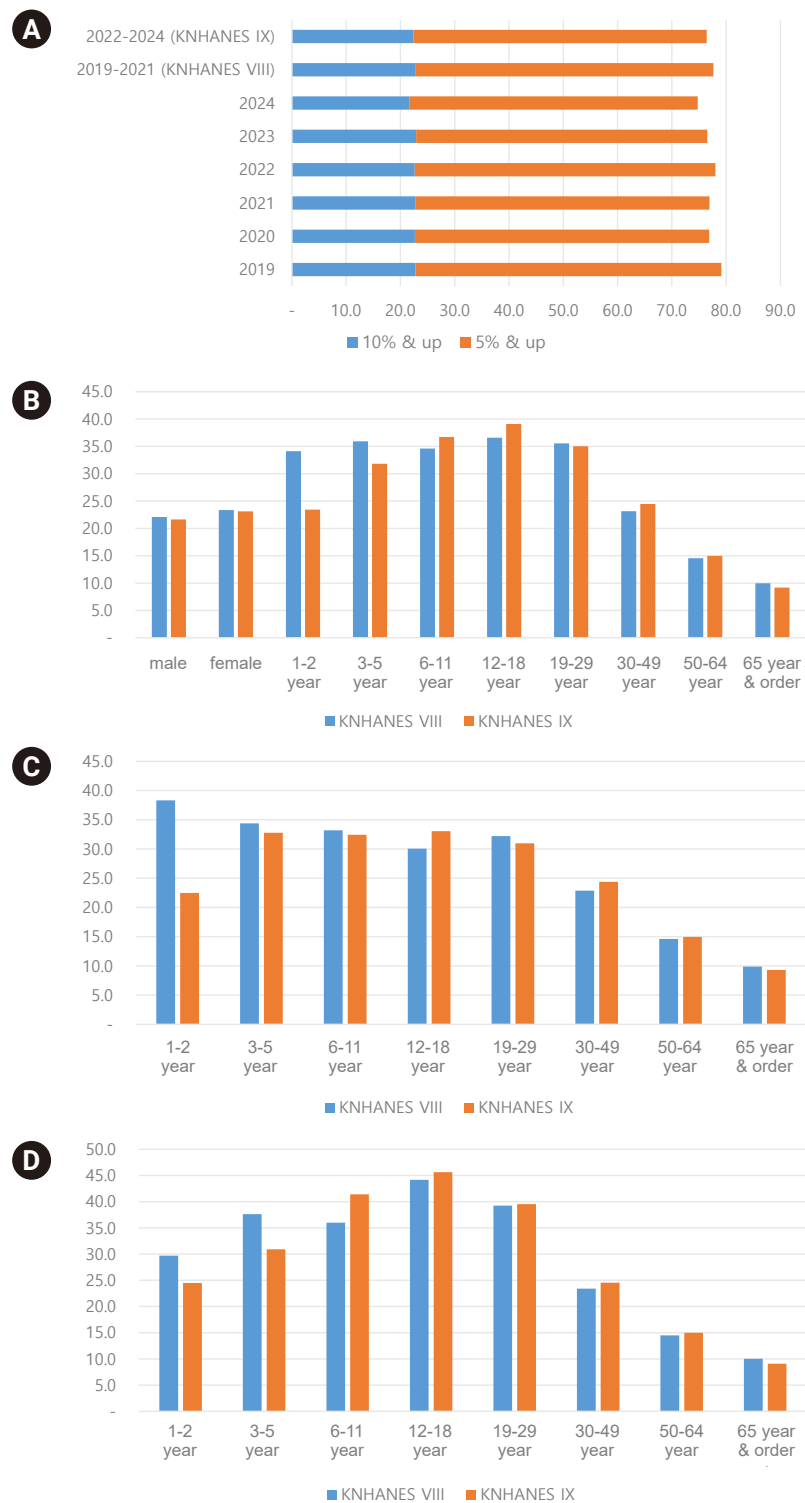


Fig. 2. Proportion (%) of population with sugar intake from processed foods exceeding the World Health Organization recommendation. (A) Comparison by year and KNHANES round in total population. (B) Comparison by age group and KNHANES round in total population. (C) Comparison by age group and KNHANES round in the male population. (D) Comparison by age group and KNHANES round in the female population. KNHANES, Korea National Health and Nutrition Examination Survey.

의 가공식품 기인 당류 섭취량과 에너지 기여 비율이 평균의 2.5–3배에 달했다. 한편, 여자 어린이의 경우엔 제9기 결과에서 75th percentile에 해당되는 어린이의 가공식품 기인 당류 섭취량의 에너지 기여 비율이 13.14%로 나타나 Fig. 2D에서 보였던 WHO 기준 초과자 비율 41.4%의 근거가 되었다.

비록 6개 연도라는 상대적으로 짧은 시계열이기는 하나 이러한 WHO 기준 초과자 비율에 대한 연도별 증감 추이를 미국 NCI의 Joinpoint Regression Program을 이용해 검정한 결과는 Table 2에 보인 바와 같으며, 여자 어린이의 경우에 비율의 연간 퍼센트 변화량 4.43% [95% confidence interval (CI) = 1.10 to 7.85, $P = 0.003$]로 유의하게 증가 추세를 보인 반면, 남자 어린이에서는 상대적으로 미미한 -1.16% (95% CI = -2.37 to -0.06 , $P = 0.036$)의 감소 추세가 나타났다.

제9기에 WHO 기준 초과자 비율이 가장 많이 증가한 집단인

어린이와 청소년(Fig. 2B)의 가공식품 기인 당류 섭취량에 대한 주요 기여 식품을 보면(Table 3), 1위는 모두 탄산음료였으며, 남녀 청소년층에서는 2위도 음료인 과일 음료였으나 어린이에서는 2위가 빵(제9기)으로 나타났다. 어린 연령층과는 반대로, 제8기 대비 제9기에 WHO 기준 초과자 비율이 오히려 감소한 65세 이상 노인층(Table 4)의 경우에는 가공식품 기인 당류 섭취량에 대한 주요 기여 식품이 전혀 달라서, 커피믹스가 1위 식품이었으며 2위에는 배추김치가 등장하였다.

DISCUSSION

총당류 섭취량에 근거해 질병관리청에서 보고[16]한 우리 국민 중 당 과잉 섭취자 분율(총당을 통한 에너지 섭취량이 20%를 초과한 분율)은, 이 연구에서 가공식품 기인 당류 섭취량에 근거

Table 1. Sugar intake among adolescent boys and school-age girls sourced from the KNHANES survey round: mean and distribution

Survey year (round)	Sugar intake	n	Mean	SE	P5	P10	P25	P50	P75	P90	P95
Adolescent boys (12–18 year)											
2019–2021 (KNHANES VIII)	Total sugar intake (g)	617	69.36	2.57	11.76	17.97	34.48	61.77	90.73	135.32	164.69
	Sugar intake from processed foods (g)	617	47.30	2.35	4.21	5.94	17.59	37.18	63.33	99.06	141.39
	Energy contribution of sugar intake from processed foods (%)	617	8.16	0.34	1.14	1.68	3.43	6.79	11.17	16.02	21.18
2022–2024 (KNHANES IX)	Total sugar intake (g)	554	69.93	2.39	11.42	22.62	36.39	56.60	94.61	131.61	161.67
	Sugar intake from processed foods (g)	554	48.19	2.12	4.63	7.62	19.03	35.73	66.41	103.95	128.81
	Energy contribution of sugar intake from processed foods (%)	554	8.88	0.35	1.49	1.96	3.77	7.35	11.58	18.50	22.23
School-age girls (6–11 year)											
2019–2021 (KNHANES VIII)	Total sugar intake (g)	640	61.63	1.82	16.14	23.08	38.59	54.40	77.87	103.20	131.45
	Sugar intake from processed foods (g)	640	37.74	1.50	3.91	7.75	16.36	29.76	51.61	74.46	90.09
	Energy contribution of sugar intake from processed foods (%)	640	9.19	0.32	1.21	2.32	4.46	7.98	12.11	16.84	21.30
2022–2024 (KNHANES IX)	Total sugar intake (g)	557	61.11	1.68	13.72	23.18	37.03	54.77	76.02	107.69	129.23
	Sugar intake from processed foods (g)	557	39.05	1.40	4.26	8.76	19.74	33.76	51.55	72.14	91.27
	Energy contribution of sugar intake from processed foods (%)	557	9.66	0.34	1.26	2.41	5.05	8.85	13.14	17.42	21.21

KNHANES, Korea Health and Nutrition Examination Survey; SE, standard error; P, percentile.

Table 2. Proportion (%) of children with sugar intake from processed foods exceeding the WHO recommendation (2019–2024)

Group	KNHANES 2019–2024 (year)						Annual percent change (95% CI)	P-value ¹⁾
	2019	2020	2021	2022	2023	2024		
6–11 year, boys	34.0	33.9	31.6	32.8	33.0	31.5	-1.16 (-2.37 , -0.06)	0.036
6–11 year, girls	36.8	32.1	39.1	39.5	40.5	44.5	4.43 (1.10 , 7.85)	0.003
12–18 year, boys	30.2	34.9	24.6	34.7	32.5	32.0	0.92 (-6.13 , 8.93)	0.769
12–18 year, girls	42.3	41.0	49.3	43.8	43.6	49.1	2.20 (-2.38 , 7.81)	0.285

WHO, World Health Organization; KNHANES, Korea Health and Nutrition Examination Survey; CI, confidence interval.

¹⁾ $P < 0.05$ based on a t-test to determine if the annual percent change is significantly different from zero.

Table 3. Sugar intake from top 10 processed foods in school-age children and adolescents

Rank	2019–2021 (KNHANES VIII)				2022–2024 (KNHANES IX)				2019–2021 (KNHANES VIII)				2022–2024 (KNHANES IX)			
	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)
School-age boys (6–11 year)																
1	Carbonated beverages	6.4	16.8	16.8	Carbonated beverages	5.2	12.7	12.7	Carbonated beverages	3.7	9.8	9.8	Carbonated beverages	4.8	12.4	12.4
2	Sherbets	2.6	6.7	23.4	Breads & rolls	3.2	7.9	20.6	Fruit drinks	2.8	7.4	17.2	Breads & rolls	2.8	7.3	19.6
3	Breads & rolls	2.5	6.6	30.0	Fruit drinks	3.2	7.9	28.6	Ice cream	2.7	7.0	24.2	Jellies	2.4	6.2	25.8
4	Fruit drinks	2.4	6.2	36.3	Jellies	2.7	6.5	35.1	Sherbets	2.3	6.1	30.4	Fruit drinks	2.4	6.1	32.0
5	Cookies	2.1	5.6	41.9	Cookies	2.2	5.5	40.6	Cookies	2.1	5.7	36.0	Cookies	2.1	5.3	37.3
6	Ice cream	1.8	4.7	46.5	Yogurt (curd)	2.1	5.2	45.8	Breads & rolls	2.1	5.5	41.6	Yogurt (curd)	1.9	4.9	42.3
7	Yogurt (curd)	1.5	3.9	50.5	Yogurt (liquid)	2.1	5.2	50.9	Jellies	2.0	5.4	46.9	Cakes	1.9	4.7	47.0
8	Jellies	1.4	3.7	54.2	Cakes	1.7	4.2	55.2	Ice milk	1.8	4.7	51.6	Milk	1.7	4.5	51.5
9	Ice milk	1.4	3.6	57.7	Milk	1.6	3.9	59.0	Yogurt (curd)	1.7	4.6	56.2	Ice cream	1.5	3.9	55.4
10	Yogurt (liquid)	1.3	3.5	61.2	Ice cream	1.5	3.7	62.7	Milk	1.5	4.0	60.2	Sherbets	1.4	3.6	59.0
Adolescent boys (12–18 year)																
1	Carbonated beverages	13.1	27.6	27.6	Carbonated beverages	10.4	21.6	21.6	Carbonated beverages	8.3	18.7	18.7	Carbonated beverages	6.4	14.6	14.6
2	Fruit drinks	2.7	5.7	33.3	Fruit drinks	3.3	6.8	28.4	Fruit drinks	4.0	9.0	27.6	Fruit drinks	3.9	8.9	23.4
3	Breads & rolls	2.6	5.5	38.8	Breads & rolls	3.0	6.3	34.7	Breads & rolls	2.7	6.0	33.7	Milk	2.6	5.9	29.4
4	Other sugar-sweetened beverages	2.1	4.4	43.2	Cookies	2.7	5.7	40.4	Yogurt (curd)	1.9	4.2	37.9	Other sugar-sweetened beverages	2.6	5.8	35.2
5	Kimchi	1.8	3.8	47.0	Other sugar-sweetened beverages	2.4	5.0	45.4	Cookies	1.8	4.1	42.0	Breads & rolls	2.3	5.2	40.4
6	Cookies	1.7	3.7	50.7	Cakes	2.3	4.9	50.2	Milk	1.8	4.0	46.1	Cakes	2.2	4.9	45.3
7	Red pepper paste	1.6	3.3	54.0	Milk	1.7	3.6	53.8	Cakes	1.8	4.0	50.0	Cookies	2.0	4.4	49.7
8	Ice cream	1.6	3.3	57.2	Yogurt (liquid)	1.5	3.1	56.9	Sherbets	1.8	3.9	54.0	Jellies	1.8	4.2	53.9
9	Yogurt (curd)	1.5	3.2	60.4	Kimchi	1.4	2.9	59.8	Other sugar-sweetened beverages	1.7	3.9	57.9	Yogurt (curd)	1.6	3.6	57.5
10	Milk	1.5	3.1	63.5	Red pepper paste	1.3	2.6	62.4	Jellies	1.7	3.8	61.6	Ice cream	1.5	3.5	61.0

KNHANES, Korea Health and Nutrition Examination Survey.

¹⁾Foods are classified at the tertiary food code level.

Table 4. Sugar intake from top 10 processed foods in older adults

Rank	2019–2021 (KNHANES VIII)				2022–2024 (KNHANES IX)				2019–2021 (KNHANES VIII)				2022–2024 (KNHANES IX)			
	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)	Food ¹⁾	Mean Proportion (g)	(%)	Cumulative proportion (%)
Elderly men (65 year & older)																
1	Coffee, with sugar & creamer	5.3	24.2	24.2	Coffee, with sugar & creamer	4.5	19.7	19.7	Coffee, with sugar & creamer	2.8	17.2	17.2	Coffee, with sugar & creamer	2.5	15.4	15.4
2	Kimchi	2.2	10.1	34.3	Kimchi	2.6	11.5	31.2	Yogurt (curd)	1.3	8.3	25.5	Kimchi	1.5	9.6	24.9
3	Breads & rolls	1.6	7.5	41.8	Breads & rolls	1.8	8.0	39.2	Kimchi	1.3	8.2	33.7	Yogurt (curd)	1.2	7.6	32.5
4	Red pepper paste	1.2	5.7	47.5	Red pepper paste	1.2	5.3	44.5	Breads & rolls	1.2	7.5	41.2	Breads & rolls	1.1	7.1	39.6
5	Carbonated beverages	1.0	4.7	52.2	Yogurt (curd)	1.1	4.7	49.1	Red pepper paste	0.8	4.7	45.9	Soy milk	1.0	6.2	45.9
6	Yogurt (curd)	0.9	4.3	56.5	Soy milk	0.9	4.1	53.3	Soy milk	0.7	4.5	50.4	Fruit drinks	0.9	5.5	51.4
7	Cookies	0.7	3.1	59.6	Fruit drinks	0.8	3.6	56.9	Fruit drinks	0.7	4.2	54.6	Red pepper paste	0.7	4.6	56.0
8	Soy milk	0.6	2.9	62.5	Cookies	0.7	3.2	60.1	Yogurt (liquid)	0.6	3.6	58.1	Carbonated beverages	0.6	3.5	59.5
9	Fruit drinks	0.6	2.6	65.1	Seasoned soy-bean paste	0.6	2.8	62.9	Cookies	0.6	3.4	61.5	Yogurt (liquid)	0.5	2.9	62.3
10	Yogurt (liquid)	0.5	2.4	67.5	Carbonated beverages	0.6	2.5	65.5	Carbonated beverages	0.5	3.0	64.5	Cookies	0.5	2.8	65.2

KNHANES, Korea Health and Nutrition Examination Survey.

¹⁾Foods are classified at the tertiary food code level.

해 산출하여 Fig. 2에 보인 WHO 기준 초과자 비율과는 성격이 많이 달라서, 직접적인 비교나 연계 설명은 불가능하다. 반면, 식품의약품안전처에서는 가공식품 기인 당류 섭취량을 우리 국민의 연령층별로 분석한 결과, 청소년의 가공식품 기인 당류 섭취량의 평균 에너지 기여 비율이 10.3%로서 WHO 기준을 초과하는 것으로 보고하였다[13]. 이는 약 15년 전의 국민건강영양조사 결과로부터 동일한 방법으로 가공식품 기인 당류 섭취량을 산출해 보고했던 선행 연구[15]에서 드러난 청소년의 가공식품 기인 당류 섭취량 에너지 비율 8.7%에 비해 20% 가까이 증가한 것으로서 정책적인 관심이 필요한 부분이라 할 것이다. 한편, 상기한 식품의약품안전처 보고서[13]의 성·연령층별 분석 결과에 의하면, 평균 에너지 기여 비율이 10%를 넘은 집단은 여자 어린이, 여자 청소년 그리고 20대 여자 성인이었으며, 2024년 국민건강영양조사 결과까지 포함해 제8기와 제9기 조사 원시자료를 분석한 본 연구에서도 여자 어린이, 청소년 그리고 20대 성인에서만 WHO 기준 초과자 비율이 33%를 넘는 것으로 나타났다(Fig. 2D), 이들을 우선적인 정책 대상으로 고려할 필요가 있음이 부각되었다. 특히 여자 어린이의 경우엔 WHO 기준 초과자 비율에 대한 Joinpoint 분석 결과에서도 유의적인 증가 추세를 보여, 짧은 기간에 대한 통계적 검정력이 제한적일 수 있음을 고려하더라도 주목할 필요가 있겠다.

한편 가공식품 기인 당류 섭취량에 대한 주요 기여 식품을 보면(Table 3), 남녀 어린이와 청소년 모두에서 1위가 탄산음료였지만, 여자 어린이를 제외한 다른 집단에서는 탄산음료에 기인하는 당류 섭취량과 기여율이 제8기 대비 제9기에 오히려 감소하였다. 이러한 결과의 원인은 탄산음료 섭취량의 전반적인 감소보다는 식품의약품안전처 보고[13]에서 드러난 것처럼 가당 탄산음료에서 소위 ‘제로’ 탄산음료로의 전이에 따른 가당 탄산음료 섭취 비율의 감소이다. 이는, 최근 국민의 건강 증진을 위한 예방 차원의 정책으로 거론되고 있는 가당 음료에 대한 ‘설탕세’ 도입에서 한 걸음 더 나아가, 인공감미료를 포함한 모든 단맛 음료를 정책 대상으로 고려하기 위한 논의도 필요함을 시사한다.

WHO에서는 이미 2023년에 인공감미료 사용 guideline [19]을 발표하면서 체중 조절을 목적으로 하는 인공감미료 사용이 효과적이거나 적절하지 않음을 강조하였다. 이에 이어 2024년 발표된 건강한 식생활 촉진을 위한 재정 정책 도입 guideline [6]에서는 ‘WHO suggests implementation of a policy to tax foods that do not contribute to a healthy diet.’이라는 권고에 대해 ‘Foods that do not contribute to a healthy diet are those that are high in saturated fatty acids, trans-fatty acids, free sugars and/or salt and/or which contain non-sugar sweeteners, and which are usually highly processed, and/or the consumption of which is associated with negative health outcomes.’라는 설명을 부연함으로써, free sugars에 더해 인공

감미료 또한 정책 대상으로 고려되어야 함을 제시하였다.

2024년 말에 이미 우리 인구의 20%를 넘어서 고령(65세 이상) 인구[20]의 당류 섭취 양상은 위에서 언급한 어린 연령층과는 전혀 달라서, 제8기 대비 제9기에 WHO 기준 초과자 비율이 감소(Fig. 2B)했고, 가공식품 기인 당류 섭취량에 대한 주요 급원으로 등장한 배추김치의 기여율이 10%를 넘나드는 것을 볼 수 있다(Table 4). 이러한 결과는 모두가 우려하는 음료 이외에도 김치처럼 제조과정에서 고과당, 설탕, 물엿 등 당류가 상당량 첨가되는 경우에 대해 주목할 필요가 있음을 뜻하며, 우리 국민의 free sugars 섭취를 줄이기 위한 정책적인 중재가 충분치 않은 현시점에서 소비자가 할 수 있는 일은 영양표시의 당류 함량이나 식품표시의 원재료 구성 및 함량을 확인하고, 정보 기반 선택(informed choice)을 하는 것뿐이라고 사료된다. 따라서 보다 적극적이고 능동적으로 우리 국민의 건강한 식생활 실천을 독려하기 위해 정부에서는 WHO guideline [6]의 권고처럼 가당 음료 등 특정 식품군에 대한 조세 또는 준조세 성격의 부담금 부과와 같은 재정 정책의 도입을 논의하고 검토할 필요가 있겠다. 이에 더해 완전한 자기 주도의 정보 기반 선택을 기대하기 힘든 아동의 건강한 식생활 실천을 독려하기 위해서는, 2023년에 발표된 WHO의 식품 마케팅의 위해로부터 아동을 보호하는 정책 guideline [21]을 참고하여, 어린이식생활안전관리특별법 제10조와[22] 동 법의 시행령[23] 제7조의2에 근거해 17년째 ‘평일 오후 5시부터 7시까지’만 적용되고 있는 고열량·저영양 어린이 기호식품 및 고카페인 함유 어린이 기호식품에 대한 텔레비전 등을 통한 광고 제한에 대해서도 정비할 필요가 있다고 하겠다.

Limitations

본 연구에 활용된 국민건강영양조사 영양조사부문 식품섭취량 조사 결과는 연중 모든 계절을 포함하여 진행된 조사결과이지만 24시간 회상법을 활용한 1일간의 섭취량 조사 결과로서 조사 방법 고유의 문제, 즉 day-to-day 변동성으로 인한 과대/과소 추정 가능성이 존재한다. 국민건강영양조사에서는 각 기별로 표본이 추출되므로 가능한 한 연도별 비교를 지양하고 기별 3년간의 데이터를 통합해 기별 비교를 수행하여 상기한 과대/과소 추정 가능성을 최소화하고자 하였으나, 대표성을 가진 표본이라 할지라도 상이한 표본에 의한 결과 차이가 실제 코호트 효과와는 무관한, 단순 횡단적 비교에서 발생하는 차이일 가능성을 배제할 수는 없겠다. 또한 원시자료에 등장하는 각 식품에 대한 가공식품 해당 여부의 판단 결과는 연구에 따라 조금씩 다를 수 있으며, 따라서 표와 그림에 제시된 수치를 유사한 관련 연구의 결과와 1:1로 비교하기보다는 본 결과 내에서의 변화 양상에 주목하기를 권고한다.

Conclusion

우리 국민의 1인 1일 평균 당류 섭취량은 질병관리청이나 식품의약품안전처의 보고처럼 최근 조금씩 감소하고 있다. 그러나 이러한 변화는 연령층에 따라 달라서, 어린이와 청소년, 그리고 젊은 성인의 경우에는 1/3 이상이 WHO의 free sugars 섭취 기준 상한을 초과하는 가공식품 기인 당류 섭취량을 보였다. 이에 더해 그 비율은 증가추세에 있어, 이러한 상황에 대한 정책적인 차원의 선제적인 대응이 필요하다고 판단된다. 만성질환 예방 차원의 국민 건강 증진을 위해 정부가 새로운 재정 정책의 설계와 도입을 논의하면서 유념해야 할 것은, WHO guideline [6]에 강조된 것처럼 ‘재정 정책의 시행으로부터 비롯되는 국민의 건강 상태의 변화는 그 정책이 장기간 유지되는 경우에만 나타날 가능성이 높다.’는 점이며, 정책 대상인 특정 식품이나 음료 등의 구매나 섭취량 변화에 근거한 정책의 효과평가를 지양하고 보다 긴 시간에 걸쳐 정책효과가 평가되어야 한다는 것이다.

CONFLICT OF INTEREST

There are no financial or other issues that might lead to conflict of interest.

FUNDING

None.

DATA AVAILABILITY

Publicly Accessible Repository. The original data presented in the study are openly available in the KNHANES, Korea Disease Control and Prevention at <https://knhanes.kdca.go.kr/knhanes/eng/main.do> (accessed on 13 January 2026).

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1. GENERAL INFORMATION

The *Korean Journal of Community Nutrition* (KJCN), the official journal of the Korean Society of Community Nutrition, is a peer-reviewed, open access journal. It is published bimonthly in February, April, June, August, October and December. KJCN aims to publish original research articles and reviews covering all aspects of community nutrition. The journal also welcomes research notes and educational materials that provide a wide range of findings of community nutrition field. Topics of interest include nutrition throughout the life cycle, nutrition assessment, nutrition education, nutritional epidemiology, dietary behavior, clinical nutrition, international nutrition, nutrition policy, food service management, food culture and other topics related to the improvement of human nutritional status.

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It is essential that at least one author of the manuscript is a member of the Korean Society of Community Nutrition. Exceptions will be made when the Editorial Committee invites authors and when researchers affiliated with institutions outside Korea submits.

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- 1) Research articles:** Research articles are reports of original research in the area of community nutrition.
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- 3) Protection of human subjects:** Research carried out on human subjects must be in compliance with the Helsinki Declaration, and authors should specify that it was reviewed and approved by an Institutional Review Board (IRB).
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Trial Registration: Clinical Research Information Service Identifier: KCT*****.

However, single-arm (pre-post) studies, pilot studies, and low-risk dietary surveys or simple nutrition education conducted within the range of usual dietary intake are not considered clinical trials and are exempt from registration. In contrast, studies in which participants are prospectively assigned to intervention and control groups, studies designed to evaluate the effects of specific nutrients, foods, dietary patterns, functional foods, health-related devices, or programs, and all comparative intervention studies, including randomized controlled trials, are considered clinical trials and require registration.

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A manuscript file without authors' information must be submitted through our online submission system (<https://submit-kjcn.or.kr>) by the corresponding author. In addition, authors should remember to upload the author's information separately. This includes the title page, copyright transfer agreement signed by all authors, IRB approval, and author checklist. You can upload these documents to the "Attachment" section on the submission site.

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1) **General:** Text must be written in Korean or English using MS Word program. The designated font style for English is Times New Roman in 11-point and the text should be 200%-spaced or double-spaced. Each page must be numbered beginning with the abstract page. Manuscripts are to have line numbers in the left margin.

2) **Title page:** The title page should include the following:

- The type of manuscript (research articles, reviews, research notes, and educational materials)
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- The names and affiliations, positions of all authors

A corresponding author should be marked with "†" at the end of the name. If some of the authors have different affiliations, superscript 1), 2), 3) should be placed at the end of each author's name in this order and the same number should be placed in front of the affiliation. 1), 2), 3) are attached in the same order, even if they belong to the same organization but have different positions.

The position of the researcher (professor, lecturer, student, researcher, etc.) should be listed in front of the affiliation. If there is no position and title, only the name is given. For minors who are not currently affiliated, submit the final affiliation, position, and school year separately.

<Example>

Youngok Kim¹⁾, Jin-Sook Yoon^{2),†}, Kil-dong Hong³⁾, Na-ra Kim⁴⁾

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When there is no funding associated with the manuscript, "None" should be stated.

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This research was supported by a grant from the National Research Foundation of Korea (Grant No. ***).

- 3) Data Analysis:** Studies using nationally representative survey data (e.g., Korea National Health and Nutrition Examination Survey [KNHANES], Korea Youth Risk Behavior Survey [KYRBS], Community Health Survey, Korea Rural Economic Institute [KREI] Food Consumption Behavior Survey, and National Health and Nutrition Examination Survey [NHANES]) should adhere to the following guidelines.

(1) Analytical Principles: Analyses must account for the complex sample design. Appropriate sampling weights should be applied in accordance with the characteristics of each dataset. For example, in KNHANES, different weights should be applied depending on the type of data combination.

(2) Presentation of Results: Key results should include the following. The sample size should be clearly presented separately to avoid confusion with the estimated values.

- Weighted estimates
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4) Arrangement of research articles: Each manuscript should be divided into the following sections in the order: Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, References, followed by Tables and Figures. These section headings and subheadings should be written in English. In case of educational materials, the contents of the results and discussion can be composed of contents, evaluation, and implications. In the case of a review, unlike the structure of a research article, it can be described as an introduction, body, and conclusion. However, a scoping review or

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Authors should present an “Ethics statement” immediately after the heading “Methods.” In case of reviews, research notes and educational materials, “Ethics statement” should be presented after introduction section.

<Example>

The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number).

<Example>

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Authors should present the study design (e.g., descriptive analysis, randomized controlled trial, cohort study, or meta-analysis) and any reporting guidelines referenced in the “Methods” section.

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This was a cross-sectional study. It was described according to the STROBE statement (<https://www.strobe-statement.org/>).

• Discussion

Authors should interpret the results and provide the Limitations and Conclusion in the latter part of the “Discussion” section.

• Conflict of Interest

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There are no financial or other issues that might lead to conflict of interest.

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Kildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript.

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Describe the person who helped write the thesis or research but was not appropriate as an author.

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We thank the physicians who performed the sample collection.

• Data Availability

Authors should provide a data availability statement. Providing access to research data is optional.

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The data that support the findings of this study are openly available in [repository name e.g. “KNHANES”] at [http://doi.org/\[doi\]](http://doi.org/[doi]).

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Educational materials	250~300	kr ≤ 3,000 en ≤ 5,000	≤ 40	≤ 10

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<Example>
[1-3] or [4, 7]

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<Example>
Kim [2], Park & Lee [5], Brown *et al.* [7]

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- References should follow the National Library of Medicine (NLM) style guide (<http://www.nlm.nih.gov/citingmedicine>).
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① *Published journal articles*

Authors. Article title. Journal title Year of publication; Volume(Issue): Start page-Last page.

<Example> Mo YJ, Kim SB. Sodium related recognition, dietary attitude and education needs of dietitians working at customized home visiting health service. Korean J Community Nutr 2014; 19(6): 558-567.

When an article has more than six authors, the names of the first six authors should be given followed by '*et al.*'

<Example> Yon MY, Lee HS, Kim DH, Lee JY, Nam JW, Moon GI *et al.* Breast-feeding and obesity in early childhood - based on the KNHANES 2008 through 2011-. Korean J Community Nutr 2013; 18(6): 644-651.

② *Forthcoming journal articles*

Authors. Article title. Journal title Year of publication. Forthcoming.

<Example> Kim YS, Lee HM, Kim JH. Sodium-related eating behaviors of parents and its relationship to eating behaviors of their preschool children. Korean J Community Nutr 2015. Forthcoming.

(2) Books

① *Entire books*

Authors. Title. Edition. Publisher; Year of publication. p. Start page-Last page.

<Example> Park YS, Lee JW, Seo JS, Lee BK, Lee HS, Lee SK. Nutrition education and counselling. 5th ed. Kyomunsa; 2014. p. 32-55.

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② *Book chapter*

Chapter authors. Chapter title. In: Editor names, editors. Book title. Edition. Publisher; Year of publication. p. Start page-Last page.

<Example> Tamura T, Picciano MF, McGuire MK. Folate in pregnancy and lactation. In: Bailey LB, editor. Folate in Health and Disease. 2nd ed. CRC press; 2010. p. 111-131.

③ *Translated books*

Translators. Translated title(translated version). Edition. Original language originally written by authors. Publisher; Year of publication. p. Start page-Last page.

<Example> Mo SM, Kwon SJ, Lee KS. Do you know dining table of children? (translated version). 1st ed. Japanese original written by Adachi M. Kyomunsa; 2000. p. 20-22.

(3) Scientific reports

Authors. Report title. Performing organization; Year of publication Month of publication. Report No. Report number.

<Example> Lee YM. A study on development of food safety and nutrition education program for preschooler. Ministry of Food and Drug Safety; 2013 Nov. Report No. 13162consumer110.

(4) Thesis and dissertation

Author. Title. [Book type]. Publisher; Year of publication. master's thesis for master degree, dissertation for doctoral degree

<Example> Ahn SY. The perception of sugar reduction in nutrition teachers or dieticians in charge of school meals and their use of added sugar in Seoul. [master's thesis]. Sookmyung Women's University; 2014.

(5) Conference papers

Authors of paper. Title of paper. Proceedings of Conference title; Year Month Day; Place of conference: p. Start page-Last page.

<Example> Shim JE. Infant and child feeding practices for development of healthy eating habits. Proceedings of 2014 Annual Conference of the Korean Society of Community Nutrition; 2014 Nov 14; Seoul: p. 195-213.

(6) Articles in magazine or newspaper

① Magazine articles

Author. Article title. Magazine title. Year Month: Page.

<Example> Lee BM. Nutrition treatment of hereditary metabolic diseases. Nutrition and Dietetics. 2013 Dec: 12-19.

② Newspaper articles

Author or Organization. Article title. Newspaper title. Year Month Day; Section: Page.

<Example> Lee JH. Sodium reduction need to readjust policy. Food and Beverage News. 2014 Sep 29; Sect. A: 1.

(7) Materials on the internet

① Web sites

Author or Organization. Title [Internet]. Publisher; Year [cited Year Month Day]. Available from: electronic address

dress

<Example> The Korean Society of Community Nutrition. Nutrient story [Internet]. The Korean Society of Community Nutrition; 2007 [cited 2015 May 12]. Available from: <http://www.dietnet.or.kr/>

② Web page

Author or Organization. Title [Internet]. Publisher; Year [updated Year Month Day; cited Year Month Day]. Available from: electronic address

<Example> Ministry of Food and Drug Safety. Winter food poisoning, be careful of norovirus [Internet]. Ministry of Food and Drug Safety; 2014 Nov 14 [updated 2014 Dec 11; cited 2015 Feb 1]; Available from: <http://www.mfds.go.kr/fm/article/view.do?articleKey=1245&searchTitleFlag=1&boardKey=4&menuKey=167¤tPageNo=1>

11) Tables and Figures: Tables and Figures must be written in English. Each table and figure should be prepared on a separate page and placed at the end of the text according to the order cited in the text. Citation of tables or figures in the text is as Table 1 or Fig. 1. Vertical lines are not used in tables. A title should be placed at the top of a table or at the bottom of a figure. The footnotes of the table are presented on Arabic numerals as superscripts 1), 2), 3). In case of indicating levels of significance, *P*-values should be presented in the body of each table, and if necessary, symbols can be used as *, **, ***, etc. To indicate the result of multi-range tests, letters such as a, b, c, etc. can be used.

9. PUBLICATION

Once the review process is completed, the manuscript cannot undergo any modifications in their contents or changes of the authors. PDF page proofs will be emailed to the corresponding author and should be returned within 3 days. The author pays the publication fee for the published paper, including manuscript editing fees, reference proofreading fees, and file processing fees. Authors who choose to withdraw a manuscript after it has undergone peer-review will be charged the review fee.

Any issues not indicated in these instructions will be reviewed and decided by the Editorial Committee. Any

additional questions or information on manuscript submission and publication can be clarified by contacting the editorial office.

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Email: kjcn45@koscom.or.kr

I. GENERAL RULES

1. Title

This code is titled as ‘The Code of Research Ethics of the Korean Society of Community Nutrition.’

2. Purpose

The purpose of the code is to establish the standard for the research ethics observed by the members of the Korean Society of Community Nutrition and the contributors to the Korean Journal of Community Nutrition, and determine the establishment and operation of the Committee on the Research Ethics (hereafter the ‘Committee’) for fair and systematic verification in the case of the scientific misconduct.

II. ETHICS CODE FOR A RESEARCHER

3. Integrity of Researcher

A researcher should conduct research and publish research results with research integrity.

4. Inclusion of Scientific Misconduct

- (1) Fabrication refers to the act of creating, documenting, or reporting the data or the research results that do not exist.
- (2) Falsification refers to the act of creating the documentation that do not match study results by manipulating the research materials, equipment, or procedures or changing or omitting data or research results.
- (3) Plagiarism refers to steal others’ ideas, procedures, results, or records without legitimate authorization.
- (4) The improper authorship refers to the act which confers authorship on the person without any academic contribution due to gratitude or seniority, or does not reward with authorship without proper cause to the person who academically contributes or devotes the research contents or results.
- (5) It includes the acts which seriously exceed generally accepted criteria.

5. Prohibition of Duplicate Submission or Duplicate Publication of Research Product

A researcher should not submit or publish the same research results in two different places.

6. Authorship

Contributors who have made substantive intellectual contributions to a paper are given credit as author and authorship is based on the following four criteria.

- (1) Substantial contributions to the conception or design of the work; or the acquisition, analysis, or interpretation of data for the work; AND
- (2) Drafting the work or reviewing it critically for important intellectual content; AND
- (3) Final approval of the version to be published; AND
- (4) Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

7. Record of Published Work

- (1) An author should accept the credit for only the accomplishments of the research he/she conducted or contributed to and take responsibility for them.
- (2) The order of the authors (including translators) of articles or other publications should be determined with fairness according to the extent of the contribution to research regardless of relative positions. Simply being in a particular position should not guarantee a credit as a co-author, the first author, or a corresponding author. Neither the act of not crediting the sufficient contribution to research with authorship can be justified. When the contribution to research is low, a statement of appreciation is expressed in a footnote, a preface, or an acknowledgement.

8. Citation and Reference

- (1) An author who cites academic materials should make efforts to describe them accurately and state their sources clearly. The materials that are obtained from personal communication can be cited with the permission from the researcher who provides information.
- (2) When an author cites or makes a reference to others' words, he/she should state the fact in a footnote, and distinguish them from his/her original thoughts or results of interpretation.

9. Role and Ethics for a Journal Editor

- (1) An editor should request a reviewer with expertise in the field, objectivity, and impartial judgment for the evaluation of submitted manuscripts.
- (2) An editor should not disclose the information about the author or the content of the manuscript until the submitted manuscript is decided to be published.

10. Role and Ethics for a Reviewer

- (1) A reviewer should evaluate the manuscript under review with commitment and impartiality within a specified period and notify a journal editor of results.
- (2) A reviewer should notify a journal editor immediately of the intention to resign from reviewing a manuscript when he/she believes oneself to be unsuitable for reviewing the manuscript.
- (3) A reviewer should evaluate a manuscript with objective criteria and impartiality without consideration of one's academic beliefs or personal relationship with its author. A reviewer should not reject a manuscript without logical reasons or on the reason that it is in conflict with his/her own view or interpretation, and rate a manuscript without reading it thoroughly.
- (4) A reviewer should respect an author's personality and individuality as an intellectual and use comments in a polite and gentle manner as much as possible, and should not use degrading or insulting expressions.
- (5) A reviewer should maintain confidentiality of a manuscript under review and should not cite the content of a manuscript prior to its publication.

III. ESTABLISHMENT AND OPERATION OF THE COMMITTEE

11. Function of the Committee

The Committee reviews and decides the issues below related to the research ethics of the members of the Korean Society of Community Nutrition.

1. The establishment of the research ethics
2. The prevention and investigation on the scientific misconduct
3. Whistleblower protection and confidentiality
4. Verification on the violation of the research ethics, process of the verification results and follow-up measures
5. Restoration in the honor of the examinee
6. Other issues imposed by the chair of the Committee

12. Organizing Principles of the Committee

The Committee consists of 5 members. The committee is chaired by the President of the Society and the Editor-in-chief serves as the associate chair of the committee. The other three are appointed by the President of the Society with the recommendation from the Executive Board.

13. Report and Receipt of the Scientific Misconduct

The whistle-blower may provide the information to the secretariat of the editorial board in the Korean Society of Community Nutrition directly or through the telephone, written document or e-mail on the real name. However, if the contents and evidence of the misconduct are specific, the report provided by an anonymous informant is considered as the case by the real-name person.

14. Authority for Verification and Recommendation of the Committee

The Committee is authorized to conduct an investigation about the allegation of the violation of the ethics code using a wide range of evidence from informants, the person under investigation, witnesses, and reference materials. The committee reviews and decides the status of violation of the ethics code based on the results of investigation, and recommends appropriate sanctions to the president based on the decision.

15. Verification Process of the Committee

The verification process for the act of violation of research ethics proceeds in the order of preliminary inquiry, investigation, and judgment. The investigation should be completed within 6 months. However, when the investigation is unlikely to be completed within the time frame, the investigation period may be extended with the committee chair's approval. When an informant or the person under investigation disagrees with the decision, he/she may file an appeal within 30 days from receiving notification, and the Committee may conduct reinvestigation if necessary.

16. Assurance of Opportunity to Be Heard

The member who is alleged to violate the Code of Research Ethics should be given a written notice of the overview of the issue under investigation. He/she is guaranteed to have an opportunity to submit a letter of explanation, and as long as he/she wishes, an opportunity to attend one or more of the Committee meetings in the investigation procedure and provide an oral explanation.

17. Confidentiality Duty for a Member of the Committee

A member of the Committee shall not disclose the identification of the reporter and the member suspected of the research ethics violation until the final decision is confirmed by the society.

18. Disciplinary Procedures and Content

In the event of proposed disciplinary measures by the Ethics Committee, the committee chair convenes the Executive Board and makes a final decision on the status and the content of discipline. The member who is determined to have violated the Code of Research Ethics may be given disciplines including warning, ban on manuscript submission for a specified period, and suspension or cancellation of membership depending on the severity of the issue, and the article may be retracted and the results may be disclosed if necessary.

19. Revision of the Code of Research Ethics

Revision procedure of the Code of Research Ethics follows the revision procedure of the code of the Society.

Authors' quick submission checklist

(※ Please include the checklist when submitting the manuscript to the submission site.)

Category	Items to review		Check
Title page	1. Title	- Spelling and typographical errors in paper titles. - Titles should be written in sentence case, with only the first word of the text and proper nouns capitalized. The study design should be included in the title or subtitle. e.g., Development and Effectiveness Evaluation of the STEAM Education Program on Food Groups for Kindergarteners -> Development and effectiveness evaluation of the STEAM education program on food groups for kindergarteners: a non-randomized controlled study - e.g., Program Evaluation using the RE-AIM Framework: A Systematic Review and Application to a Pilot Health Promotion Program for Children -> Evaluation of the pilot health promotion program for children: a systematic review	
	2. Author Information	- Include all author titles and affiliations, and indicate the position before the affiliation	
	3. Submission	- The title page, the copyright transfer agreement, and IRB approval are all included when submitting your paper to the submission site by uploading them to the 'Attachment' section. - Remove the cover page including author information from the submitted paper before submitting	
	4. ORCID	- ORCID should be stated for all authors e.g., Gildong Hong: https://orcid.org/https://orcid.org/0000-0000-0000-0000	
	5. Funding	- e.g., This research was supported by a grant from the National Research Foundation of Korea (Grant No. 000). - When there is no funding associated with the manuscript, 'None.' should be stated.	
Abstract	1. Structure	- Objectives-Methods-Results-Conclusion	
	2. Keywords	- Three to five keywords are recommended with one or two words except for technical terms. - The terminology should be listed, in principle, in MeSH (www.nlm.nih.gov/mesh/MBrowser.html). - Keywords are written in lowercase letters except for proper nouns, and keywords are separated by a semicolon (;).	
	3. Abbreviations	- Abbreviations should only be used if they are repeatedly used throughout the abstract. If an abbreviation is not used after it has been defined, use the full name instead - Define an abbreviation the first time it appears in the abstract	
Main body	1. Structure	- Title page, Abstract, Introduction, Methods (including ethics statement), Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability References, Tables, and Figures - Include 'Study Design' in Method, subheadings in Results, and 'Limitations' and 'Conclusion' in Discussion - Upload tables and figures as a single file and do not separate them	
	2. Statistical software	- Enter the correct type and version of statistical software e.g., IBM SPSS Statistics 25 (IBM Corp.) e.g., SAS 9.4 (SAS Institute)	
	3. Ethics Statement	- Authors should present an "Ethics Statement" immediately after the heading "Methods". In case of reviews, research notes and educational materials, "Ethics statement" should be presented after introduction section e.g., The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number: ***). *IRB approval statement will be included in the final version, but do not include specific IRB information (e.g., institution name) when submitting. - e.g., Obtainment of informed consent was exempted by the institutional review board.	

(continued to the next page)

(Continued)

Category	Items to review	Check
4. Conflict of Interest	- Conflict of interest must be stated. e.g., There are no financial or other issues that might lead to conflict of interest. - e.g., Gildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest. - *Author information will be included in the final version but do not include it when submitting.	
5. Acknowledgments	- List individuals who contributed to the writing or research, but do not meet the criteria for authorship. e.g., We thank the physicians who performed the sample collection. - *This information will be included in the final version, but do not include it when submitting.	
6. Data Availability	- Authors should provide a data availability statement. Providing access to research data is optional. e.g., The data that support the findings of this study are openly available in [repository name e.g. "KNHANES"] at http://doi.org/[doi].	
7. References	- Notation method: [1], [2, 5], [15-20], etc. without spaces before square brackets, when adding commas between references, add a space after commas. e.g., research on something [1] or Kim & Lee's research [2, 5] - References in the text should be listed in numerical order - The number of citations for the type of dissertation should not exceed 3. - Verify that the reference adheres to the KJCN guidelines	
8. Other indications such as units	- Write numbers and units with a space (50 kg, 600 kcal), but attach % and °C. - g/dl (X), g/dL (O) - When indicating P-value, use capital, italic P: e.g., <i>P</i>-value - Use a en-dash "–" to indicate a range of numbers: e.g., 20–25 - Use comma notation to separate thousands (this also applies to text and tables): For example, 65,450,000.	
9. Tables, figures	- Capitalize only the first letter of table and figure titles - Capitalize only the first letter of variables in the table - Use lowercase 'n' in tables and figures. - Additional checklists for tables and figures can be found in the section below.	

*Examples shown in the tables are based on recent publication, 2024.

GUIDELINE FOR TABLES AND FIGURES

Please adhere the following guidelines for tables and figures.

1. To indicate the total number of items outside of the table's body, include it in parentheses at the end of the table's title.
For example, "Sociodemographic characteristics of children (n = 80)"
2. The table heading should provide a descriptive title for the values presented, rather than simply using "Mean $\pm$ SD" as the title.
3. When describing the contents of the table in the text:
 - ① To present an average value, use Mean $\pm$ SD or Mean $\pm$ SE, and be mindful of spacing (e.g., 22.0 $\pm$ 2.3, with a space before and after the ' $\pm$ ' symbol)
 - ② Units should be written in parentheses within the table (e.g., Energy (kcal/day)) instead of next to it (Energy, kcal/day)
4. Footnotes or legends explanations for tables or figures should be written in English
5. The footnotes or legends should be arranged in the following order: Values displayed as statistical outcomes, statistical analysis method, indication of significance, etc.
 - ① The presentation of values of statistical outcomes, such as n (%), Mean $\pm$ SD, n (%) or Mean $\pm$ SD, etc, are displayed in the first line of the footnote without comment numbers.
 - ② Statistical analysis method and significance indication - Both statistical analysis methods and significance are discussed. - Post-hoc analysis results can only be presented when the ANOVA test yields significant results.
 - ③ The full name of any abbreviations used in the title or table body should be provided in the footnote.
 - ④ Any other content that requires explanation should be accompanied by corresponding comment numbers, following the submission guidelines. Verify that the comment numbers match the numbers indicated in the table body.

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Author(s): _____

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1. 학회지의 특성

(2024년 10월 15일 개정)
(2026년 6월 10일 최종 개정)

본 학회지는 대한지역사회영양학회의 학술지로서, 전문가 심사를 거친 논문만을 게재하고, 논문 전문은 학회 홈페이지를 통해 공개된다. 학회지는 2개월마다(2월, 4월, 6월, 8월, 10월, 12월) 발행되며, 발행일은 발간월의 마지막 날이다. 생애주기영양, 영양판정, 영양교육, 영양역학, 식행동, 임상영양, 국제영양, 영양정책, 급식 및 외식 관리, 식문화와 기타 지역사회영양학 분야의 연구논문(research articles), 종설(reviews), 연구단보(research notes), 교육자료(educational materials) 등을 게재할 수 있다.

2. 투고 자격

저자 중 적어도 1명이 대한지역사회영양학회 회원이어야 투고할 수 있으며, 비회원의 경우 편집위원회에서 위촉 또는 국외 기관에 소속된 저자가 투고할 시 가능하다.

3. 원고의 종류

- 1) **연구논문:** 지역사회영양학 분야의 새로운 논문
- 2) **종설:** 특정 주제에 대하여 간결하고 정확하게 최신문헌 및 견해를 기술한 논문, 체계적인 문헌고찰은 PRISMA 가이드라인을 따라야 함
- 3) **연구단보:** 지역사회영양학과 관련된 새로운 아이디어, 연구방법, 정책적 이슈 등에 대한 토의 보고
- 4) **교육자료:** 영양교육 프로그램의 내용과 활용, 또는 새로운 교육 접근방법 등에 관한 논문

4. 연구 및 출판윤리

- 1) **이중게재:** 원고는 다른 학회지에 발표되거나 투고되지 않은 것이어야 한다.
- 2) **저자됨:** 원고의 저자는 연구설계, 자료 수집 및 분석, 원고 작성에 기여를 하고, 연구와 관련된 문제의 조사와 해결에 책임을 다할 것을 동의한 자이어야 한다.
- 3) **피험자 보호:** 연구의 대상이 사람인 경우 헬싱키 선언에 입각하여 피험자를 보호하여야 하며, 연구를 수행하기 전 기관생명윤리위원회(Institutional Review Board; IRB)의 승인을 받아야 한다.
- 4) **임상시험:** 임상시험은 인간 피험자를 전향적으로 중재군과

비교군에 배정하여 중재와 건강결과 간 인과관계를 평가하는 연구를 말한다. 이러한 연구는 시작 전에 공인된 임상시험 등록기관(WHO ICTRP, ClinicalTrials.gov, ISRCTN Register, Clinical Research Information Service [CRIS])에 등록하여야 하며, 등록번호를 초록 말미에 다음과 같이 기재한다.

〈예〉

Trial Registration: Clinical Research Information Service Identifier: KCT*****.

다만, 단일군(pre-post) 연구 또는 파일럿 연구, 일상적 식생활 범위 내의 저위험 식이조사 및 단순 영양교육은 임상시험으로 간주하지 않아 등록을 요구하지 않는다. 반면, 피험자를 전향적으로 중재군과 대조군으로 배정한 연구, 특정 영양소·식품·식이패턴·기능성 식품·건강관련 기기 또는 프로그램의 효과를 검증하기 위한 연구, 그리고 무작위배정연구를 포함한 모든 비교중재연구는 임상시험으로 간주하여 등록을 요구한다.

임상시험 해당 여부가 불명확한 경우에는 국제 기준에 따라 판단하며, 필요 시 편집위원장이 최종 결정한다.

- 5) **이해관계:** 연구를 지원하는 회사나 기관과 경제적 또는 개인적 관계가 있는 경우 이를 논문에 명백하게 기술해야 한다.
- 6) **윤리규정 준수:** 저자는 본 학회 연구윤리규정을 준수하여야 하며, 본 규정에 언급되지 않은 연구 및 출판윤리에 대해서는 국제표준출판윤리규정(<http://publicationethics.org/international-standards-editors-and-authors>)을 적용한다.
- 7) **저작권:** 본 학회지에 게재된 논문의 저작권은 본 학회에 귀속된다. 논문투고 시 모든 저자는 저작권이전동의서에 사인하여 제출해야 한다.
- 8) **프리프린트(preprint):** 본 학회지는 프리프린트로 사전 공유된 연구논문을 허용하지 않는다.

5. 성(SEX)/젠더(GENDER)에 대한 고려

논문에서 결과에 영향을 줄 수 있는 인자로 생물학적 성(sex) 또는 사회문화적 성인 젠더(gender)를 인식하고 이에 대한 아래 내용을 논문에 포함하여야 한다.

- 성별 기술에서 성(sex)과 젠더(gender)를 구분하여 올바르게 기술한다.
- 연구 대상에 남성과 여성을 대상으로 포함하여 연구하고 그 결과를 비교분석하여 논문을 발표한다.
- 단일 성을 대상으로 연구한 경우는 학술적으로 타당한 근거를 제시한다.

6. 논문투고

교신저자는 온라인투고시스템(<https://submit-kjcn.or.kr>)으로 저자정보가 삭제된 원고파일을 제출한다. 저자정보가 포함된 표지, 모든 저자의 서명이 작성된 IRB 승인서 사본, 저자체크리스트는 온라인 투고사이트 ‘첨부파일’에 업로드 한다.

7. 전문가 심사

편집위원장 또는 편집위원은 저자정보가 삭제된 투고논문을 두 명의 전문가에게 심사하도록 보내고, 심사자는 대한지역 사회영양학회지의 심사규정에 따라 심사한다. 편집위원장은 심사자의 의견에 따라 첫 번째 결정을 내리고 6주 안에 교신저자에게 알린다.

두 명의 심사자의 의견이 다를 때에는 또 다른 심사자에게 심사하도록 한다.

8. 원고 작성법

1) 원고 작성: 원고는 MS 워드를 사용하여 한글 또는 영문으로 작성한다. 글자 크기는 11 point, 행간은 200% 또는 2줄 간격으로 하며, 영문 글꼴은 Times New Roman으로 한다. 영문초록을 1쪽으로 하여 쪽번호를 표기하며, 원고 왼쪽 여백에 줄 번호를 매긴다.

2) 표지: 다음의 내용을 포함한다.

- 원고의 종류(연구논문, 종설, 연구단보, 교육자료)
- 압축한 제목(Running head)은 공백 포함 50자 이내의 영문으로 기재
- 제목을 국문논문은 국문과 영문 모두 기재, 영문논문은 영문만 기재
- 영문 제목은 기본적으로 소문자로 작성(단, 문장의 첫 단어와 고유 명사는 대문자로 작성). 관찰 연구(단면조사연구, 환자-대조군 연구 또는 전향적 코호트 연구), 임상 연구, 체계적 문헌고찰 또는 메타 분석의 경우 제목 또는 부제목에 연구디자인 제시
- 저자, 소속 및 직위를 국문과 영문으로 기재, 단 영문논문

의 경우 영문으로만 기재

교신저자 이름 뒤에는 “†” 표시를 윗첨자로 하여 붙이고, 소속기관이 다를 경우는 저자이름 끝에 1), 2), 3)을 윗첨자로 하여 순서에 따라 붙이고, 해당인의 소속기관명 앞에 같은 숫자를 붙인다. 소속이 같으나, 직위가 다를 경우에도 1), 2), 3)을 윗첨자로 하여 순서에 따라 붙인다. 연구자의 직위(교수, 강사, 학생, 연구원 등)는 영문의 경우 소속 앞에 기재한다. 소속과 직위가 없는 경우에는 이름만 기재한다. 현재 소속이 없는 미성년자의 경우 최종 소속, 직위, 재학년도를 별도로 제출한다.

〈예〉

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- 교신저자의 성명, 주소 및 전화번호, 팩스번호, 전자우편주소를 영문으로 기재. 전화와 팩스번호는 국가코드도 표기

〈예〉

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- ORCID (<https://orcid.org/>)

모든 저자는 ORCID 등록시 소속과 직위를 등록해야하며, 이는 추후 저자신분 확인이 필요할 경우 자료로 활용할 수 있다. 모든 저자의 ORCID 번호를 블라인드 없이 표기하며, 그 예는 다음과 같다.

〈예〉

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- 연구지원내역(Funding)

해당하는 내용이 없더라도 ‘None.’ 으로 기재한다.

〈예〉

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3) **자료 분석:** 국가 단위 조사자료(예: 국민건강영양조사, 청소년건강행태조사, 지역사회건강조사, KREI 식품소비행태조사, NHANES 등)를 활용한 연구는 다음 기준을 따른다.

(1) **분석 원칙:** 모든 분석은 복합표본설계(complex sample design)를 고려하여 수행해야 한다. 각 조사자료의 특성에 맞는 적절한 가중치(weight)를 적용해야 한다. 예를 들어 국민건강영양조사는 자료 결합 유형에 따라 상이한 가중치를 사용한다.

(2) **결과 제시:** 주요 분석 결과는 다음을 포함하여 제시해야 하며, 표본 수(sample size)는 결과값과 혼동되지 않도록 별도로 명확히 제시해야 한다.

- 가중치가 적용된 추정값 (weighted estimate)
- 표준오차 (standard error, SE)

(3) **연구방법 기술:** 다음의 내용을 연구방법(Methods)에 기술한다.

- 사용한 조사자료의 조사 연도 및 차수(wave)를 명확히 기술하며 해당 자료의 공식 인용 형식을 준수한다.
- 이차자료 분석 시 기관생명윤리위원회(IRB) 승인 또는 심의 면제 여부를 명시한다.
- 사용한 통계 프로그램 및 분석 절차를 구체적으로 기술한다. (예: SPSS Complex Samples, SAS Survey Procedures 등)

(4) **복합표본설계 적용 예외:** 원칙적으로 복합표본설계 분석은 필수이나, 다음과 같은 경우 예외가 허용될 수 있다. 다만, 복합표본설계를 적용하지 않은 사유를 명확히 제시하고, 해당 연구의 제한점을 고찰(Discussion)에서 반드시 언급해야 한다.

- 복합표본설계와 호환되지 않는 분석 방법을 사용하는 경우 (예: 매개효과 분석)
- 특정 하위집단 분석 등으로 인해 표본 수가 제한적인 경우

4) **원고의 구성:** 원고의 부제목은 모두 영문으로 작성하고, 구성은 다음과 같다. Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability, References, Tables, Figures 순으로 한다. 단, 교육자료의 경우 결과와 고찰의 내용을 콘텐츠(Contents), 평가(Evaluation), 시사점(Implications) 등의 내용으로 구성할 수 있다. 종설의 경우 연구논문의 구성과 달리 서론, 본론, 결론의 구성으로 기술할 수 있다. 그러나 주제범위 고찰(scoping review)이나 체계적 고찰(systematic review)은 연구논문의 구성을

따라야 한다.

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• 연구윤리(Ethics Statement)

저자는 "방법(Method)" 연구윤리에 관해 영문으로 기술해야 한다. 부제목 바로 아래에 제시하며 종설, 연구노트, 교육자료 등의 경우에는 서론 뒤(본론 전)에 제시한다.

〈예〉

The informed written consent was obtained from each participant.

The study protocol was approved by the Institutional Review Board of *** (approval number: IRB승인번호).

〈예〉

Obtainment of informed consent was exempted by the institutional review board.

• 연구설계(Study design)

저자는 "방법(Methods)" 연구설계에 연구설계(기술분석, 무작위 대조연구, 코호트 연구 또는 메타 분석 등) 및 참고한 보고지침을 제시한다.

〈예〉 This was a cross-sectional study. It was described according to the STROBE statement (<https://www.strobe-statement.org/>).

• 고찰(Discussion)

저자는 결과를 해석하고 "고찰(Discussion)"의 후반부에 Limitations 및 Conclusion을 제시한다.

• 이해상충(Conflict of Interest)

〈예〉

There are no financial or other issues that might lead to conflict of interest.

〈예〉

Kildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest.

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논문작성이나 연구를 도왔지만 저자로서 적절하지 않은

분 등을 기술한다.

〈예〉

We thank the physicians who performed the sample collection.

• 데이터가용성(Data Availability)

저자는 데이터가용성에 대한 설명을 작성해야하며, 데이터에 대해 접근을 허용하는 것은 선택사항이다.

〈예〉

The data that support the findings of this study are openly available in [repository name e.g. “KNHANES”] at [http://doi.org/\[doi\]](http://doi.org/[doi]).

5) 원고의 분량: 다음의 분량을 준수한다.

논문 유형	초록 (단어)	본문 (단어)	참고문헌	표·그림
연구논문	250~300	국문 ≤ 3,000 영문 ≤ 5,000	≤ 40	≤ 10
총설	250~300	국문 ≤ 3,000 영문 ≤ 5,000	≤ 50	≤ 10
연구단보	250~300	국문 ≤ 1,750 영문 ≤ 3,000	≤ 30	≤ 5
교육자료	250~300	국문 ≤ 3,000 영문 ≤ 5,000	≤ 40	≤ 10

6) **영문초록:** 영문초록은 목적(Objectives), 연구방법(Methods), 결과(Results), 결론(Conclusion)의 소제목으로 구분하여 250~300단어로 작성한다. 초록 아래쪽에 주제어(Keywords)를 영문으로 표기한다.

7) **키워드:** 전문 용어를 제외한 1~2개의 단어로 구성된 3~5개의 키워드를 기재한다. 해당 키워드는 MeSH(<https://meshb.nlm.nih.gov/search>)에 검색되는 단어로 작성한다. 키워드는 고유명사를 제외하고 모두 소문자로 표기하며, 구분 기호는 세미콜론(;)으로 작성한다.

8) **약어:** 제일 처음 나오는 곳에 완전한 이름을 먼저 표기한 후 괄호 안에 약어를 표기하며, 표 또는 그림에 사용된 약어는 각주 또는 그림 설명에서 설명한다.

9) **수량 및 단위:** 수량은 아라비아 숫자로, 도량단위는 SI 단위를 권장한다. %, °를 제외한 모든 단위는 숫자와 띄어 쓴다.

10) 참고문헌

- 본문 중에는 인용된 순서대로 [] 안에 번호로 기재한다.
- 본문의 한 문장에서 여러 개의 참고문헌을 인용할 때에는 다음과 같이 기재한다.

〈예〉 Kim [3]은, Park & Lee [5]는, Brown 등[7]은

- 본문 중에 참고문헌의 저자를 기재하는 경우 영문 last name을 표기한다. 저자가 2명일 경우에는 두 저자 사이에 &를 삽입하고, 3인 이상일 때는 제1저자만 표기하고 “등”을 쓴다.

〈예〉 Kim [3]은, Park & Lee [5]는, Brown 등[7]은

- 참고문헌 목록은 인용된 순서에 따라 아라비아 숫자와 함께 영문으로 표기한다.
- The National Library of Medicine (NLM) 표준체제(<http://www.nlm.nih.gov/citingmedicine>)를 따라 작성한다.
- 학회지명은 약어로 표기하되 국제 약어 관례(PubMed 등재지 검색 사이트 <http://www.ncbi.nlm.nih.gov/journals>) 또는 KoreaMed 등재지 검색 사이트(<http://www.koreamed.org/JournalBrowserNew.php>)를 참고한다.
- 학위논문은 필요한 경우 3개 이내로 인용한다.

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11) 표 또는 그림

표와 그림은 영문으로 작성하며, 한 장에 하나씩 작성하여 인용된 순서대로 본문 뒤에 첨부한다. 본문에 인용할 때는 Table 1 또는 Fig. 1 등으로 표기한다. 표 작성 시에는 종선은 사용하지 않는 것을 원칙으로 하며, 표의 제목은 표의 상단에, 그림의 제목은 그림의 하단에 기재한다. 각주는 1), 2), 3) 등으로 나타내고 하단에 그 내용을 표시한다. 단, 통계분석의 유의성 표시는 표 본문에 *P*-values 를 제시하는 것으로 하고, 필요한 경우 *, **, *** 등으로, 필요한 경우 *, **, *** 등으로, 다중 범위 검정에서는 a, b, c 등으로 사용한다.

9. 출판

심사가 끝난 논문은 내용이나 저자를 바꿀 수 없다. 교신저자는 교정본 PDF 파일을 e-mail로 받으면 3일 이내에 교정하여 보내야 한다. 원하는 저자에 한하여 게재된 논문의 별쇄본 20부를 제공한다. 저자는 게재된 논문의 게재료로 원고 편집비, 참고문헌 교정비, 파일 가공비 등 소요되는 비용을 부담한다. 단, 심사과정이 시작된 이후 논문을 철회한 경우에는 논문의 심사 단계에서 발생한 심사료 비용을 부담한다. 본 규정에 명시되지 아니한 사항은 편집위원회의 심의를 거쳐 결정한다.

논문투고와 출판 관련 모든 문의사항은 편집사무실로 연락한다.

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제정 2008. 1. 21
1차 개정 2010. 4. 19
2차 개정 2014. 3. 28
3차 개정 2020. 2. 28

제1장 총칙

제1조 (명칭)

이 규정은 “대한지역사회영양학회 연구윤리규정”이라 한다.

제2조 (목적)

이 규정은 대한지역사회영양학회 회원 및 대한지역사회영양학회지 투고자가 지켜야 할 연구윤리의 기준을 확립하고, 연구부정 행위 발생 시 공정하고 체계적인 검증을 위한 연구윤리위원회(이하 “위원회”라 한다)의 설치 및 운영에 관한 사항을 규정함을 목적으로 한다.

제2장 연구자의 윤리규정

제3조 (연구의 진실성)

연구자는 연구의 진실성을 준수하여 연구를 수행하고 그 결과를 발표하여야 한다.

제4조 (연구부정행위의 범위)

연구부정행위는 다음 각 호와 같다.

1. 위조란 존재하지 않는 데이터나 연구 결과를 만들어 내고 이를 기록하거나 보고하는 행위를 의미한다.
2. 변조란 연구자료, 장비 또는 과정을 조작하거나, 데이터나 연구 결과를 변경하거나 생략하여 연구 기록이 연구결과와 부합하지 않게 하는 행위를 의미한다.
3. 표절이란 정당한 권한 없이 타인의 아이디어, 과정, 결과 또는 기록을 도용하는 것을 의미한다.
4. 부당한 논문저자 표시란 연구내용 또는 결과에 대하여 학문적으로 공헌 또는 기여를 한 사람에게 정당한 이유없이 논문저자 자격을 부여하지 않거나, 학문적으로 공헌 또는 기여를 하지 않은 자에게 감사의 표시 또는 예우 등을 이유로 논문저자 자격을 부여하는 행위를 말한다.
5. 기타 통상적으로 용인되는 범위를 심각하게 벗어난 행위를 포함한다.

제5조 (연구물의 중복 투고 및 이중 게재금지)

연구자는 연구결과를 중복 투고 및 이중 게재 하지 않아야 한다.

제6조 (저자됨)

저자는 출판하는 논문의 연구에 지적인 공헌을 한 자로서 다음 각 호의 자격을 모두 충족하여야 한다.

1. 연구의 구상이나 설계 또는 자료의 수집이나 분석이나 해석을 하는 데 있어서 상당한 공헌을 한 자
2. 논문의 초안을 작성하거나 주요 내용을 검토한 자
3. 출간될 원고를 최종 승인한 자
4. 연구의 정확성이나 무결성과 관련된 문제를 적절히 조사하고 해결하는 것에 책임이 있음을 동의한 자

제7조 (출판 업적의 명기)

- ① 저자는 자신이 행하거나 기여한 연구에 대해서만 업적을 인정받으며 그에 대한 책임을 진다.
- ② 논문이나 기타 출판의 저자(역자 포함)의 순서는 상대적 지위에 관계없이 연구에 기여한 정도에 따라 공정하게 정해져야 한다. 단순히 특정 직책으로 인하여 공동저자, 제1저자, 또는 교신저자가 될 수 없다. 연구에 충분히 기여했음에도 저자로 인정되지 않는 행위 또한 정당화될 수 없다. 연구에 대한 기여도가 낮을 경우 각주, 서문, 사의 등에서 사사의 글로 표시한다.

제8조 (인용 및 참고 표시)

- ① 저자가 학술 자료를 인용할 경우에는 정확하게 기술하도록 노력해야 하고 출처를 명확히 밝혀야 한다. 개인적인 접촉으로 얻은 자료의 경우에는 정보를 제공한 연구자의 동의를 받은 후 인용할 수 있다.
- ② 저자가 타인의 글을 인용하거나 참고할 경우에는 각주를 통해 인용 및 참고 여부를 밝혀야 하며, 선행연구의 결과인 부분과 저자의 독창적인 견해 또는 해석의 결과인 부분이 구분될 수 있도록 하여야 한다.

제9조 (논문 편집위원회의 역할 및 윤리)

- ① 편집위원은 투고된 논문을 해당 분야의 전문적 지식과 객관적이고 공정한 판단 능력을 지닌 심사위원에게 평가 하도록 의뢰하여야 한다.
- ② 편집위원은 투고된 논문의 게재가 결정될 때까지는 저자에 대한 사항이나 논문의 내용을 공개하지 않아야 한다.

제10조 (논문 심사위원의 역할 및 윤리)

- ① 심사위원은 심사 대상 논문을 심사규정이 정한 기간 내에 성실하고 공정하게 평가하고 결과를 편집위원에게 통보하여야 한다.
- ② 심사위원은 자신이 논문의 내용을 평가하기에 책임자가 아니라고 판단될 경우에는 편집위원에게 즉시 사퇴의사를 통보하여야 한다.
- ③ 심사위원은 심사 대상 논문을 개인적인 학술적 신념이나 저자와의 사적인 친분 관계를 떠나 객관적 기준에 의해 공정하게 심사하여야 한다. 충분한 근거를 명시하지 않은 채 논문을 탈락시키거나, 심사자 본인의 관점이나 해석과 상충된다는 이유로 논문을 탈락시켜서는 안 되며, 심사 대상 논문을 제대로 읽지 않은 채 평가하지 않아야 한다.
- ④ 심사위원은 전문 지식인으로서의 저자의 인격과 독립성을 존중하여야 하고, 평가의견은 가급적 정중하고 부드러운 표현을 사용하여 저자를 비하하거나 모욕적인 표현을 해서는 안 된다.
- ⑤ 심사위원은 심사 대상 논문에 대한 비밀을 지켜야 하며, 논문이 게재된 학술지가 출판되기 전에 논문의 내용을 인용해서는 안 된다.

제3장 연구윤리위원회의 설치와 운영

제11조 (위원회의 기능)

위원회는 대한지역사회영양학회 회원의 연구윤리와 관련된 다음 각 호의 사항을 심의, 의결한다.

1. 연구윤리 확립에 관한 사항
2. 연구부정행위의 예방, 조사에 관한 사항
3. 제보자 보호와 비밀유지에 관한 사항
4. 연구윤리 위반 검증 및 검증결과 처리와 후속조치에 관한 사항
5. 피조사자 명예회복 조치에 관한 사항
6. 기타 위원회 위원장이 부여하는 사항

제12조 (위원회의 구성)

위원회는 위원 5인 이상으로 구성하며, 위원장은 학회장으로 하고 부위원장은 편집위원장으로 하며 그 외 3인은 상임 이사회의 추천을 받아 학회장이 임명한다.

제13조 (연구부정행위의 제보 및 접수)

제보자는 대한지역사회영양학회 편집위원회 사무국에 직접 또는 전화, 서면, 전자우편 등으로 제보할 수 있으며 실명으로 제보해야 한다. 단, 익명제보라 하더라도 구체적인 연구부정행위의 내용과 증거를 포함하여 제보한 경우 이를 실명제보에 준한다.

제14조 (위원회의 검증 및 심의 권한)

위원회는 윤리규정 위반으로 보고된 사안에 대하여 제보자, 피조사자, 증인, 참고인 및 증거자료 등을 통하여 폭넓게 조사를 실시할 수 있고, 그러한 조사 결과에 따라 윤리규정 위반여부를 심의·판정한다.

제15조 (위원회의 검증 절차)

연구윤리 위반행위에 대한 검증절차는 예비조사, 본조사, 판정의 단계로 진행하며 모든 조사 일정은 6개월 이내에 종료되어야 한다. 단, 이 기간 내에 조사가 이루어지기 어렵다고 판단될 경우에는 위원장의 승인을 거쳐 조사 기간을 연장할 수 있다. 제보자 또는 피조사자가 판정에 불복할 경우에는 통보를 받은 날로부터 30일 이내에 이의신청을 할 수 있으며, 윤리위원회에서 이를 검토하여 필요한 경우 재조사를 실시할 수 있다.

제16조 (소명기회의 보장)

연구윤리규정 위반으로 보고된 회원에게는 조사대상이 된 사안의 개요를 서면 통지하고 정해진 기간 내에 소명서를 제출할 기회를 보장하고 본인이 희망하는 경우 본 조사 절차 중 1회 이상 윤리위원회의 회의에 출석하여 구술로 해명할 수 있는 기회를 주는 등 충분한 소명 기회를 주어야 한다.

제17조 (연구윤리위원의 비밀 보호 의무)

연구윤리위원은 제보자의 신원을 노출시켜서는 안 되며, 학회의 최종 결정이 내려질 때까지 연구윤리규정 위반으로 보고된 회원의 신분을 공개해서도 안 된다.

제18조 (징계의 절차 및 내용)

위원회의 징계 건의가 있을 경우, 위원장은 상임이사회를 소집하여 징계 여부 및 징계 내용을 최종적으로 결정한다. 연구윤리규정을 위반했다고 판정된 회원에 대해서는 사안의 경중을 고려하여 경고, 일정기간의 논문투고금지, 회원자격의 정지 또는 박탈 등의 징계를 할 수 있으며, 필요한 경우 논문 게재 취소와 그 결과를 공개할 수 있다.

제19조 (연구윤리규정의 개정)

연구윤리규정의 개정 절차는 본 학회의 규정 개정절차에 준한다.

(2024년 10월 15일 개정)

[논문 투고 전 저자 확인사항]

(※ Check 후 투고사이트에 함께 제출합니다.)

구분	확인사항	Check
논문표지	1. 제목 - 논문제목 철자 및 오타 - 영문 제목은 기본적으로 소문자로 작성(단, 문장의 첫 단어와 고유 명사는 대문자로 작성) 관찰 연구(단면조사연구, 환자-대조군 연구 또는 전향적 코호트 연구), 임상 연구, 체계적 문헌고찰 또는 메타 분석의 경우; 제목 또는 부제목에 연구디자인 제시 예) Development and Effectiveness Evaluation of the STEAM Education Program on Food Groups for Kindergarteners -> Development and effectiveness evaluation of the STEAM education program on food groups for kindergarteners: a non-randomized controlled study 예) Program Evaluation using the RE-AIM Framework: A Systematic Review and Application to a Pilot Health Promotion Program for Children -> Evaluation of the pilot health promotion program for children: a systematic review	
	2. 저자정보 - 저자, 소속 및 직위를 국문과 영문으로 기재, 단 영문논문의 경우 영문으로만 기재, 영문 기재시 소속 앞으로 직위 표기 - 저자 중 1인 이상은 학회 회원일 것. 단, 비회원의 경우 편집위원회에서 위촉 또는 국외 기관에 소속된 저자가 투고할 시 가능	
	3. 제출 - 논문표지는 본 체크리스트 및 저작권이전동의서, IRB승인서와 함께 투고사이트 '첨부파일'에 업로드 (투고사이트에 논문 제출시 동시 제출, 투고논문에는 표지부분 삭제)	
	4. ORCID - 모든 저자의 ORCID 기술 예) Gildong Hong: https://orcid.org/0000-0000-0000-0000	
	5. Funding (연구지원내역) 예) This research was supported by a grant from the National Research Foundation of Korea (Grant No. 000). - 해당하는 내용이 없더라도 'None.' 으로 기재	
영문초록	1. 작성순서 - Objectives-Methods-Results-Conclusion 의 순서	
	2. 키워드 - 전문 용어를 제외한 1~2개의 단어로 구성된 3~5개의 키워드 기재 - 키워드는 MeSH (https://meshb.nlm.nih.gov/search)에 검색되는 단어로 작성 - 키워드는 고유명사를 제외하고 모두 소문자로 표기하며, 구분 기호는 세미콜론(;)으로 작성	
	3. 약어사용 - 약어를 정의하고, 그 약어가 논문에서 더 이상 사용되지 않는다면 약어 사용할 필요 없음. 전체 명칭 (full name)으로 작성 - 약어를 두 번 이상 본문에서 사용할 경우, 맨 처음 약어가 등장할 때 전체 명칭에 대해 약어 정의	
논문본문	1. 작성순서 - 원고의 부제목은 모두 영문으로 작성 - Title page, Abstract, Introduction, Methods, Results, Discussion, Conflict of Interest, Acknowledgments, Data Availability, References, Tables, Figures 순서로 작성 - Method의 Study design, Results의 소제목, Discussion의 Limitations, Conclusion 반드시 작성 - 투고 시 표, 그림을 포함하여 하나의 파일로 업로드	
	2. 통계 패키지 정보 기입 - 종류 및 버전 정확히 기입 예) IBM SPSS Statistics 25 (IBM Corp.) 예) SAS 9.4 (SAS Institute)	
	3. Ethics Statement (연구윤리) - 저자는 "방법(Method)" 부제목 바로 아래에 연구윤리에 관해 영문으로 기술. 종설, 연구노트, 교육자료 등의 경우에는 서론 뒤(본론 전)에 영문으로 제시. 예) The informed written consent was obtained from each participant. The study protocol was approved by the Institutional Review Board of *** (approval number: ***). *IRB 기관표시는 최종본에 기재(투고시 내용 삭제후 업로드) 예) Obtainment of informed consent was exempted by the institutional review board.	
	4. Conflict of Interest (이해상충) 예) There are no financial or other issues that might lead to conflict of interest. 예) Gildong Hong has been an editor since 2021. However, he was not involved in the review process of this manuscript. Otherwise, there was no conflict of interest. *저자정보는 최종본에 기재(투고시 내용 삭제후 업로드)	

(continued to the next page)

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구분	확인사항	Check
5. Acknowledgments (감사의 글)	- 논문작성이나 연구를 도왔지만 저자로서 적절하지 않은 분 등을 기술. 예) We thank the physicians who performed the sample collection. *관련내용은 최종본에 기재(투고시 내용 삭제후 업로드)	
6. Data Availability (데이터가용성)	- 저자는 데이터가용성에 대한 설명을 작성해야하며, 데이터에 대해 접근을 허용하는 것은 선택사항 예) The data that support the findings of this study are openly available in [repository name e.g “KNHANES”] at http://doi.org/[doi] .	
7. 참고문헌	- 표기방법: 대괄호[] 앞 띄어쓰기 없이 [1], [2, 5], [15-20] 등 표기, 문헌 사이 쉼표 추가시, 쉼표 뒤 띄어쓰기 예) ~에 관한 연구[1] 또는 Kim & Lee의 연구[2, 5] - 본문 내 참고문헌의 인용이 번호순으로 되어 있는지 확인 - 학위 논문 인용은 3개 이내로 제한 - 참고문헌 표기 규정에 맞는지 확인	
8. 단위 등 기타 표시	- 숫자와 단위 띄어쓰기(50 kg, 600 kcal), 단, %, °C 붙임 - g/dl(X), g/dL(O) - P값 표기 시 : P 대문자, 기울임체 : 예) <i>P</i> -value - 숫자 등의 범위 표기 시 ‘-’를 사용: 예) 20-25 - 천 단위 쉼표 표기(본문, 표에도 적용): 예) 65,450,000	
9. 표, 그림	- 표와 그림 제목: 첫 글자만 대문자 - 표에서 변수들 영문 표기시 : 첫 글자만 대문자 - 표와 그림에서 n을 소문자로 표기 - 투고규정에 따르며 그 외 형식은 별첨한 가이드라인에 따름	

*예시는 2024년도 최근 게재논문을 참고.

[논문 투고 전 저자 확인사항_표와 그림]

표와 그림 작성 시 다음의 사항을 유의하여 주시기 바랍니다.

1. 자료의 전체 수를 표 본문의 내용 밖으로 표시하고자 할 때는 표 제목 끝의 괄호 안에 제시
예) Sociodemographic characteristics of children (n = 80)
2. 표 본문의 제목줄(table head)은 가능하면 제시된 값을 설명하는 것으로 하고, 단순히 Mean $\pm$ SD 등만을 제목으로 하는 것을 지양함
3. 표 본문의 내용 작성 시
 - 평균값을 제시하는 경우 Mean $\pm$ SD, Mean $\pm$ SE 으로 사용, 띄어쓰기 확인
예) 22.0 $\pm$ 2.3 : ' $\pm$ ' 앞뒤로 띄어쓰기
 - 표에서 단위는 괄호 안에 넣어서 표기
예) Energy (kcal/day) (O)
Energy, kcal/day (X)
4. 표와 그림을 설명하는 주석은 모두 영문으로 표기
5. 주석의 기술 순서는 가능하면 자료의 형태, 통계분석 방법 및 유의성 표시, 기타의 순서로 작성함
 - 1) 자료의 형태 제시
예) n (%), Mean $\pm$ SD, n (%) or Mean $\pm$ SD 등 주석 번호 없이 첫줄에 제시
 - 2) 통계분석 방법 및 유의성 표시
 - ① 통계적 유의성 뿐 아니라 통계분석 방법도 함께 제시함
 - ② 사후검정 결과는 분산분석 등의 유의확률 제시가 선행되어야 함
 - 3) 약어를 사용한 경우 전체 명칭(full name)을 주석으로 제시함
 - 4) 기타 설명이 필요한 내용은 이후 투고규정에 따라 순서대로 번호를 달고 각주로 제시하며 표 본문에 표기한 번호와의 일치여부 확인