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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

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 (*banchan*) 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:

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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 (BMI < 18.5 kg/m^2), normal weight (18.5 ≤ BMI < 23 kg/m^2), overweight (23 ≤ BMI < 25 kg/m^2), and obese (BMI ≥ 25 kg/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 '≥ 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* (β = −1.532) and *baechu kimchi* (β = −1.018). Among women, significant de-

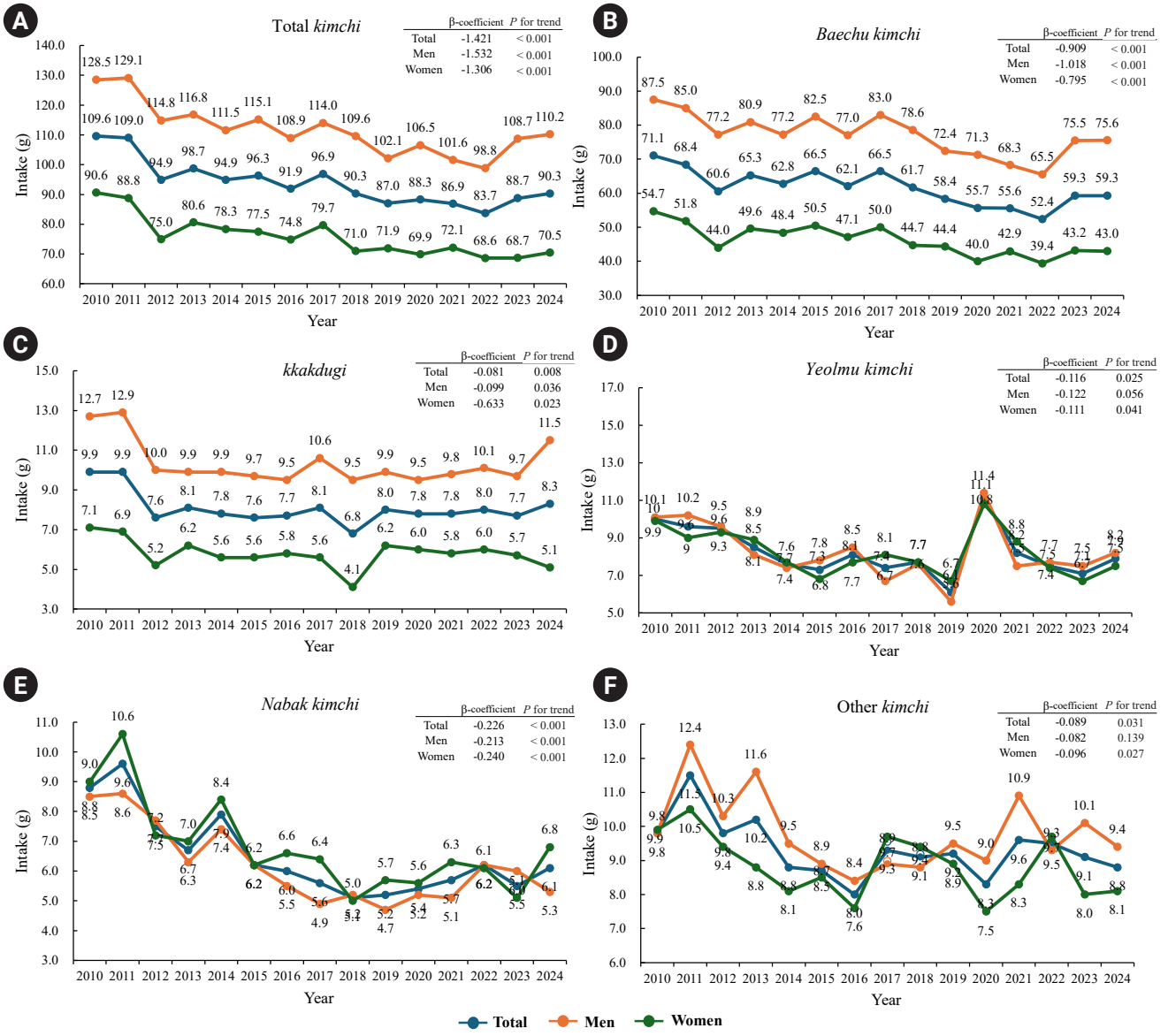

Fig. 1. Trends in *kimchi* consumption by gender among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of (A) total *kimchi*, (B) *baechu kimchi*, (C) *kkakdugi*, (D) *yeolmu kimchi*, (E) *nabak kimchi*, and (F) other *kimchi*. 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.

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clining trends were observed across all *kimchi* types (*P* for trend < 0.001); total *kimchi* (β = –1.306) showed the greatest absolute decline, with *baechu kimchi* (β = –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 (β = –0.623, *P* < 0.001), with similar patterns in men (β = –0.641, *P* < 0.001) and women (β = –0.632, *P* < 0.001). *Baechu kimchi* demonstrated a significant decline (β = –0.378, *P* < 0.001), consistent in women (β = –0.384) and

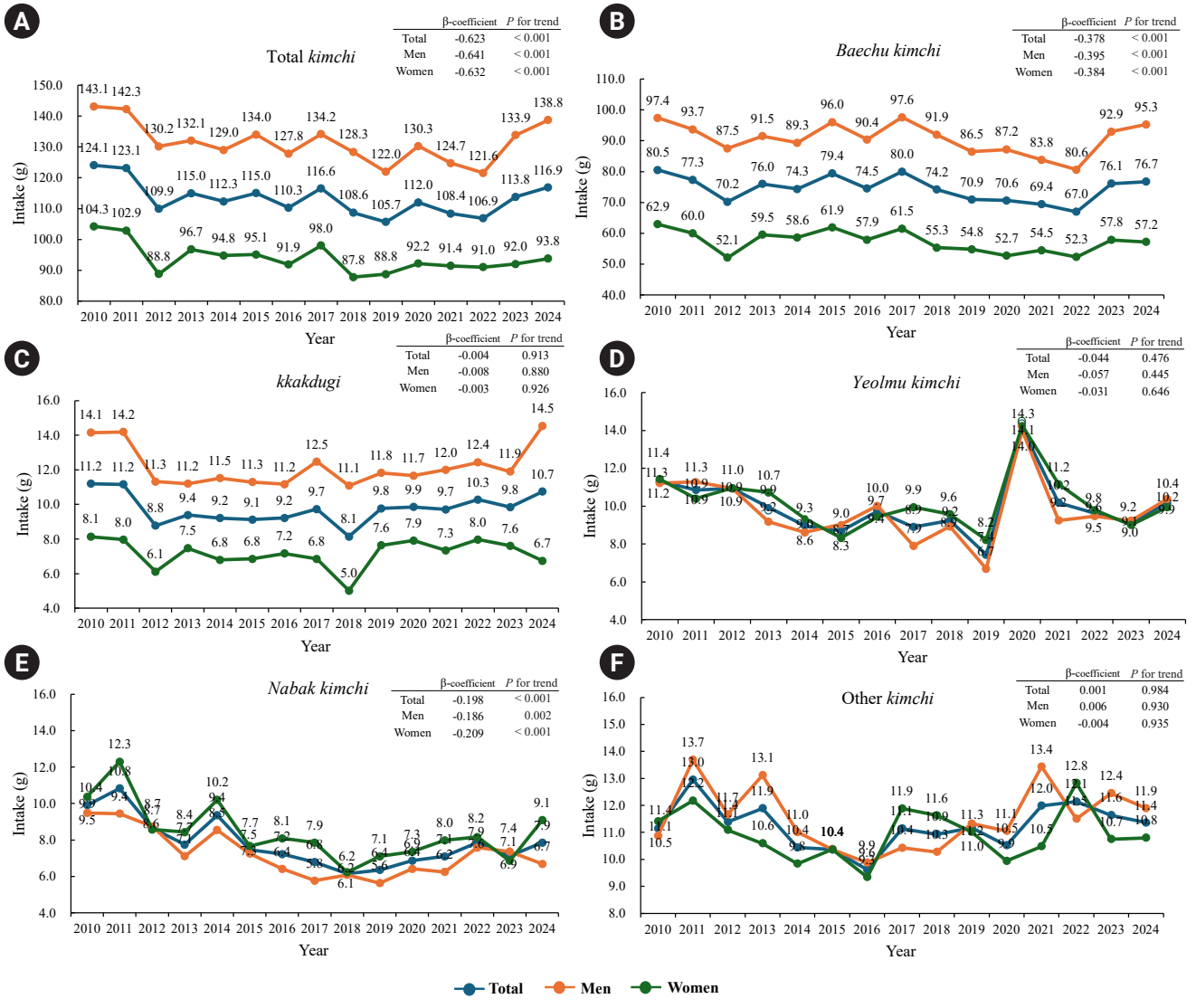

Fig. 2. Trends in *kimchi* consumption by gender among participants in the *kimchi* intake group, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of (A) total *kimchi*, (B) *baechu kimchi*, (C) *kkakdugi*, (D) *yeolmu kimchi*, (E) *nabak 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 (β = –0.395). *Nabak kimchi* also showed a statistically significant decreasing trend in the *kimchi* consumer subgroup for both genders. Annual changes in *kkakdugi*, *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 (β = –0.888), followed by the 40–59 year (β = –0.499) and 10–19 year (β = –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 (β = 0.888), followed by the 40–59 year (β = 0.499) and 10–19 year (β = 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 (β = –1.352) and 20–39 year (β = –1.345) groups, followed by the 10–19 year group (β = –0.613). At school/workplace settings, *kimchi* intake increased significantly only in the 0–9 year group (β = 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 (β = –0.2034). Restaurant-based *kimchi* consumption exhibited divergent patterns: a declining trend was observed in the 20–39 year group (β = –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 (β = 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

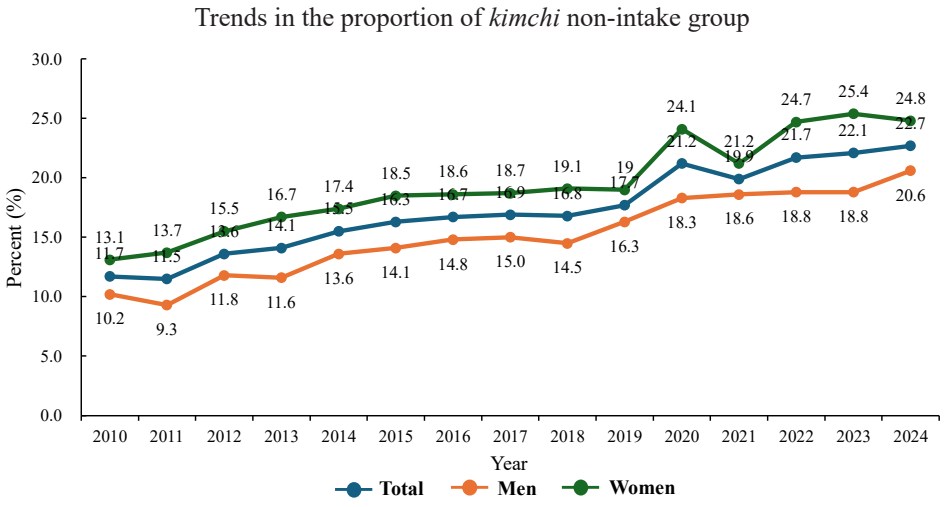

Fig. 3. Trends in the proportion of the *kimchi* non-intake group by gender among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. Values are presented as survey-weighted percentages (%). Blue lines indicate the total population, orange lines indicate men, and green lines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

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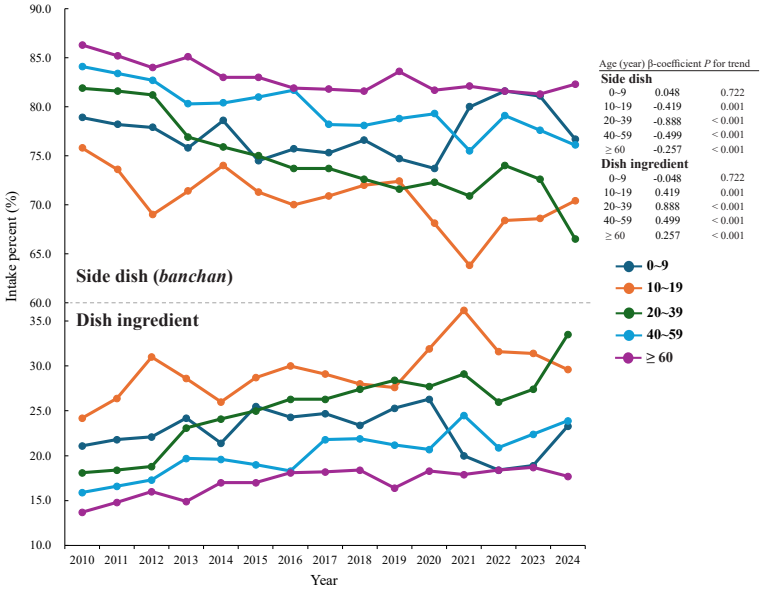

Fig. 4. Age-specific trends in *kimchi* consumption patterns among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the proportion (%) of *kimchi* consumed as a side dish (upper panel) and *kimchi* consumed in dish ingredient (lower panel). Lines represent 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.

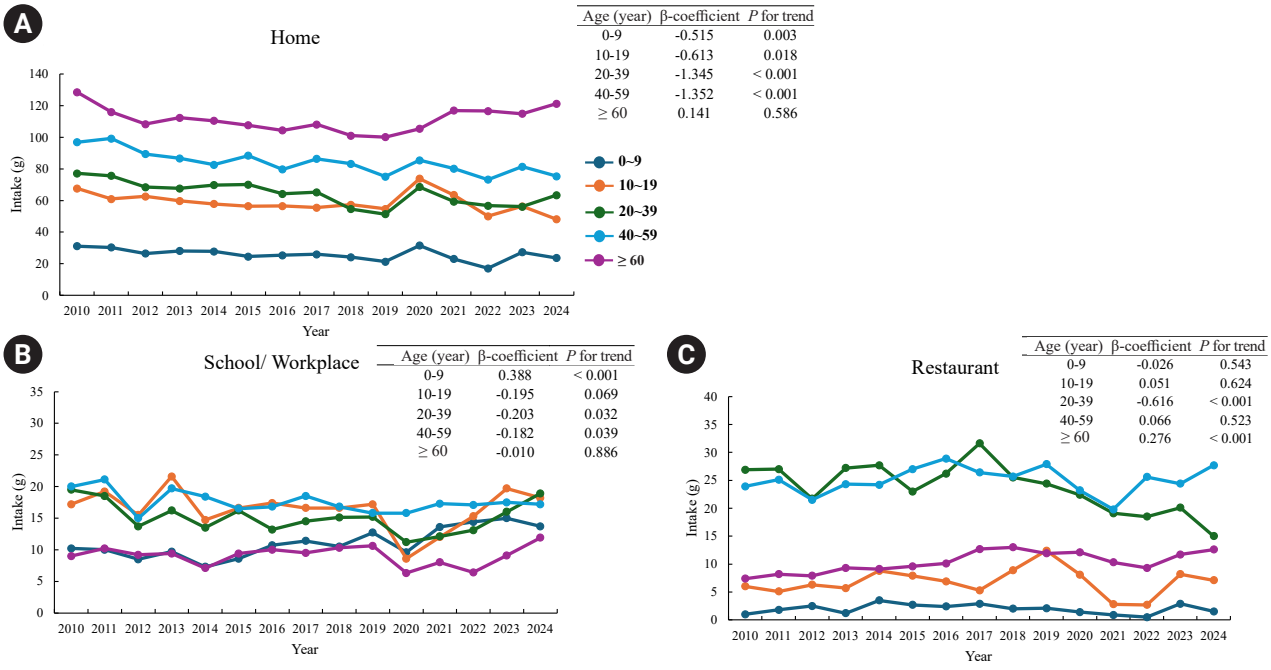

Fig. 5. Age-specific trends in *kimchi* consumption by meal location among Korean adults, Korea National Health and Nutrition Examination Survey 2010–2024. The panels show the mean daily intake (g/day) of *kimchi* consumed at home, school/workplace, and restaurants for each age group: (A) home, (B) school/workplace, 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 *kimchi*	*Baechu kimchi*	*Kkakduki*	*Yeolmu kimchi*	*Nabak kimchi*	Other *kimchi*
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*	*Kkakduki*	*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/m^2), normal (18.5 kg/m^2 < BMI ≤ 23 kg/m^2), overweight (23 kg/m^2 < BMI ≤ 25 kg/m^2), obese (≥ 25 kg/m^2).

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 *kimchi* ≥ 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 *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	1.16 (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 genderes (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

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Table 4. Multivariable-adjusted age-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			
	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 *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	0.81 (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 *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	1.33 (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

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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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