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Original Article

Dietary patterns and intrinsic capacity in older adults: a 6-year prospective cohort study

Jinhee Kim [a,b], Yunhwan Lee [a,b,*], Miji Kim [c,*], Chang Won Won [d], Mi Kyung Kim [e], Jee-Seon Shim [f,g]

[a] Department of Preventive Medicine and Public Health, Ajou University School of Medicine, 164 World cup-ro, Youngtong-gu, Suwon 16499, Republic of Korea
[b] Institute on Aging, Ajou University Medical Center, 164 World cup-ro, Youngtong-gu, Suwon 16499, Republic of Korea
[c] Department of Biomedical Science and Technology, College of Medicine, East-West Medical Research Institute, Kyung Hee University, 23 Kyung Hee Dae-ro, Dongdaemun-gu, Seoul 02447, Republic of Korea
[d] Department of Family Medicine, Kyung Hee University Medical Center, 23 Kyung Hee Dae-ro, Dongdaemun-gu, Seoul 02447, Republic of Korea
[e] Department of Preventive Medicine, College of Medicine, Hanyang University, 222 Wangsimni-ro, Seongdong-gu, Seoul 04763, Republic of Korea
[f] Cardiovascular and Metabolic Diseases Etiology Research Center, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea
[g] Department of Preventive Medicine, Yonsei University College of Medicine, 50-1 Yonsei-ro, Seodaemun-gu, Seoul 03722, Republic of Korea

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ABSTRACT

Objectives: Only a few studies have investigated dietary patterns and intrinsic capacity (IC). This study examined the prospective associations between dietary patterns, IC, and IC sub-domains over 6 years in community-dwelling Korean older adults.
Design: A prospective cohort study.
Setting and participants: Data were obtained from participants aged 70–84 years in the Korean Frailty and Aging Cohort Study (2016–2022). The study population included 665 enrollees at baseline who completed IC and dietary data.
Methods: Dietary data were obtained from baseline surveys of the nutritional sub-cohort using two nonconsecutive 24-hour dietary recalls, and dietary patterns were derived using cluster analysis. IC was constructed by measuring cognitive, locomotor, vitality, sensory, and psychological domains. A generalized estimating equation was used to analyze the longitudinal associations between dietary patterns, IC, and IC sub-domain scores.
Results: In total, 665 enrollees were included in the analysis. After adjusting for confounders, in older men, the dietary pattern of cluster 1 (variety of healthy foods and alcohols) compared to that of cluster 2 (rice and kimchi) was positively associated with changes in the IC score (ß = 0.41, 95% confidence interval [CI] = 0.04−0.78). In older women, the dietary pattern of cluster 1 (variety of healthy foods) was positively associated with changes in the IC score (ß = 0.30, 95% CI = 0.02–0.58), IC score group (ß = 0.11, 95% CI = 0.02–0.20), and psychological domain (ß = 0.25, 95% CI = 0.11–0.38) compared to that of cluster 3 (rice, vegetables, and kimchi).
Conclusions: Dietary patterns (variety of healthy foods) were positively associated with changes in IC scores and their sub-domains in older adults.

1. Introduction

In Korea, population aging is progressing rapidly, with the proportion of people aged ≥65 years estimated to be 15.7% in 2020 and projected to increase to 46.4% by 2070 [1]. However, with an increase in lifespan, there has been no significant change in health span [2]. In 2015, the World Health Organization published the World Report on Aging and Health [3], which considered the health of older adults from a disease-to function-based perspective [4]. Functional ability is determined by intrinsic capacity (IC), environment, and the interaction between the two

Abbreviations: AMDR, acceptable macronutrient distribution range; CI, confidence interval; GEE, generalized estimating equation; IC, intrinsic capacity; MNA-SF, Mini Nutritional Assessment Short Form; Ref., reference; SD, standard deviation; SPPB, Short Physical Performance Battery.

* Corresponding author.
E-mail addresses: yhlee@ajou.ac.kr (Y. Lee), mijiak@khu.ac.kr (M. Kim).

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[4]. IC consists of five domains: cognitive, locomotion, vitality, sensory, and psychological [5]. It predicts negative health outcomes, including frailty, falls, mortality, and poor quality of life [6].

Dietary habits are an important modifiable factor in healthy aging [7], and a balanced diet consisting of vegetables, fruits, whole grains, lean proteins, and healthy fats has been associated with a lower risk of chronic illnesses and improved general health in older persons [8]. However, most previous studies have reported on diet and sub-domains of IC [9,10]. Only a few studies have examined diet and IC [11,12]. In a three-year longitudinal study of older Japanese adults, adherence to the “fruits and vegetables” and “protein-rich” patterns was associated with higher IC and adherence to the “sugar and fat” pattern was associated with lower IC [11]. In a cross-sectional study targeting older Chinese adults living in Hong Kong, various dietary patterns were related to IC and its sub-domains in older men, whereas they were related only to the psychological domain in older women [12]. However, because the diet of older Korean adults differs from that of older Japanese and Chinese adults, there are limitations in applying the results of previous studies to older Korean adults.

This study aimed to examine the six-year longitudinal associations between dietary patterns, IC, and IC sub-domains in community-dwelling Korean older adults.

2. Methods

2.1. Study population

Data were obtained from the Korean Frailty and Aging Cohort Study (2016–2022). Baseline surveys were conducted among community-dwelling older adults aged 70–84 years in South Korea from May to November 2016 at eight hospitals affiliated with universities and two public health centers. Follow-up surveys were conducted every two years. The details of this study have been reported previously [13]. The Institutional Review Board of Ajou University Hospital approved this study (AJOUIRB-DB-2024-044), which was conducted in accordance with the guidelines of the Declaration of Helsinki. All participants provided written informed consent.

2.2. Assessment of dietary intake and dietary patterns

From September 2016 to November 2017, dietary intake was investigated using data from baseline surveys of the nutritional sub-cohort, which included two-thirds of the baseline participants. Trained interviewers conducted two nonconsecutive 24-h dietary recalls during home visits spaced three–ten months apart. Pictures of bowls, plates, and food were used to examine the amount of food consumed the previous day. Based on the National Rural Living Science Institute database [14], the Korea Disease Control and Prevention Agency and the National Institute of Health’s 24-h recall dietary assessment system was used to calculate food and nutrient intake. Individual foods were divided into 20 food groups based on their comparable nutritional content and characteristics [14]. For dietary pattern analysis, the percentage of energy intake from each food group was calculated.

Dietary patterns were determined by cluster analysis using the k-means method. Cluster analysis revealed three dietary patterns among men (Table 1). Cluster 1 included 33.9% of the participants and had a higher consumption of a variety of food groups, such as fruits, meats, eggs, milks, and alcohols. Approximately 24.5% of the participants were allocated to cluster 2, where rice consumption accounted for 62.7% of the total energy intake and kimchi consumption was higher than that in the other two groups. The remaining 41.7% of the participants were allocated to cluster 3, which was based on rice but had a variety of food groups such as pulses, vegetables, fishes and shellfishes. Cluster analysis revealed three dietary patterns in women. Cluster 1 was allocated to 40.2% of the participants who had a higher consumption of a variety of food groups, such as pulses, nuts and seeds, fruits, meats, and milks. Next, 17.3% of the

Table 1
Mean food and nutrient intake by dietary pattern groups.

	Men (n = 319)						Women (n = 346)					
	Cluster 1 (n = 108)		Cluster 2 (n = 78)		Cluster 3 (n = 133)		Cluster 1 (n = 139)		Cluster 2 (n = 60)		Cluster 3 (n = 147)	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Food groups (% of energy)												
Rice	28.9	6.9	62.7	8.5	45.4	5.2	31.4	9.0	35.9	8.6	55.5	8.7
Rice cakes	2.4	4.9	0.9	3.4	1.1	3.3	3.5	6.1	2.8	5.3	1.8	4.3
Other grains	3.0	3.7	1.9	2.4	2.8	3.5	3.5	4.3	3.0	3.0	3.1	3.5
Noodles & dumplings	9.5	9.5	1.7	4.6	1.9	3.7	1.9	4.0	15.9	6.5	1.0	2.9
Flour & bread	3.1	5.6	0.4	1.8	1.5	3.8	4.6	7.0	2.1	4.6	1.2	3.2
Potatoes & starches	3.1	5.3	1.1	2.5	1.7	3.1	3.8	4.8	2.3	3.8	2.0	3.6
Sugars & sweeteners	1.6	1.5	1.1	0.9	1.6	1.2	1.7	1.4	1.8	1.3	1.4	1.2
Pulses	2.9	3.0	2.8	2.7	3.8	4.4	4.1	4.9	3.2	4.1	2.8	2.8
Nuts & seeds	1.3	2.1	1.0	2.0	1.1	2.5	1.7	3.0	1.1	1.8	0.9	1.8
Vegetables	4.1	1.8	3.8	1.9	4.9	2.2	4.4	2.2	4.0	1.8	4.6	2.7
Kimchi	1.3	1.1	1.5	0.9	1.3	0.9	1.0	0.8	1.4	1.1	1.4	1.1
Fruits	5.5	5.2	3.1	3.3	4.4	3.5	8.6	6.7	5.0	4.0	4.7	4.2
Meats	10.3	7.6	3.7	4.7	8.0	7.0	9.5	9.6	3.6	4.0	4.1	4.7
Eggs	2.1	2.5	0.6	1.4	1.0	1.6	2.0	2.8	2.1	2.2	1.1	1.9
Fishes & shellfishes	4.4	4.7	4.7	4.2	6.8	6.0	4.6	4.5	5.1	5.4	4.6	4.2
Milks	2.9	3.3	2.0	3.5	1.6	2.8	5.5	5.7	2.5	3.3	2.0	3.5
Oils & fats	3.4	2.2	2.5	2.1	3.8	2.3	3.5	2.4	4.3	3.3	3.4	2.3
Beverages	2.0	2.3	1.8	2.0	2.2	2.4	2.0	2.4	1.4	1.9	1.8	2.1
Alcohols	5.7	9.6	0.5	2.4	2.5	6.2	0.1	0.7	0.2	1.3	0.1	0.4
Seasonings	2.5	1.8	2.3	1.8	2.6	1.6	2.6	2.2	2.2	1.3	2.4	1.5
Nutrient												
Energy (kcal)	1660.4	426.7	1464.1	358.9	1635.5	350.4	1337.4	394.7	1271.7	307.2	1188.0	297.6
Carbohydrate (% of energy)	62.4	7.1	73.9	5.6	65.8	6.1	63.4	8.7	68.1	5.7	72.4	5.8
Protein (% of energy)	16.4	3.2	13.7	2.3	16.3	3.3	15.7	3.1	14.6	2.5	14.0	2.3
Fat (% of energy)	21.2	5.6	12.4	4.3	17.9	4.9	20.9	7.2	17.3	5.0	13.6	4.5
Carbohydrate (g)	250.0	73.0	268.9	62.3	265.7	57.8	215.1	63.7	218.9	52.7	216.7	51.7
Protein (g)	64.9	20.0	50.5	16.3	65.8	17.8	53.6	19.0	47.3	14.0	42.2	13.3
Fat (g)	38.1	15.2	20.7	9.8	32.6	12.9	32.5	17.0	25.3	11.1	18.6	8.8

Abbreviations: SD, standard deviation.

participants were allocated to cluster 2, which had a higher consumption of noodles and dumplings, fishes and shellfishes. Cluster 3 comprised 42.5% of the participants, in which rice consumption accounted for 55.5% of the total energy intake, and the consumption of vegetables and kimchi was higher than that in the other two groups.

2.3. Assessment of IC

To create IC, five domains were measured: cognition, locomotion, vitality, sensory function, and psychological function [5]. The IC scoring system suggested by López-Ortiz et al. [15] was used. The score of each IC domain ranges from 0 to 2 (i.e., 0 = severely impaired domain; 1 = partially impaired; and 2 = slightly impaired or fully preserved), with a composite score of 0 (worst IC possible) to 10 (highest), and is grouped into three categories: high and stable capacity (10–9 points, scoring = 2), declining capacity (8–5 points, scoring = 1), and significant loss of capacity (4–0 points, scoring = 0). Cognition was evaluated using the Mini-Mental State Examination in the Korean version of the CERAD Assessment Packet [16] and was scored, using mean and standard deviation (SD) stratified by age, educational level, and sex [17], as 0 (mean-2.0 SD), 1 (mean-1.5 SD ∼ mean-2.0 SD), and 2 (mean-1.5 SD). Locomotion was assessed using a Short Physical Performance Battery (SPPB) [18], which included the following tests: balance test (side-by-side stance [<10.0 s = 0, ≥10.0 s = 1], semi-tandem stance [<10.0 s = 0, ≥10.0 s = 1], and tandem stance [<3.0 s = 0, 3.0–9.9 s = 1, ≥10.0 s = 2]), and 4-m walking speed (walking speed over 4 m was measured using an automatic timer (Gaitspeedometer; Dynamicphysiology, Daejeon, Korea), with acceleration and deceleration phases of 1.5 m. Mean values were selected after two measurements. The quintiles of walking speed stratified by sex and height based on the cohort profile [13] were created to score 0–4 points. The 5-time sitting down and getting up from a chair was categorized as 0 (≥60.00 s), 1 (16.70–59.99 s), 2 (13.70–16.69 s), 3 (11.20–13.69 s), and 4 (≤11.19 s). The total SPPB score ranges from 0 to 12 and is classified as 0 (0–2 points), 1 (3–9 points), or 2 (10–12 points). Vitality was assessed using the Korean version of the Mini Nutritional Assessment Short Form (MNA-SF) [19] and scored as 0 (0–7 points), 1 (8–11 points), or 2 (12–14 points). Sensory function was assessed by measuring distance visual acuity and pure-tone audiometry. Distance visual acuity was scored as 0 (<0.1 [6/60]), 0.5 (0.1 [6/60]≤vision<0.33 [6/18]), or 1 (≥0.33 [6/18]) based on the vision of the better eye (corrected vision) [20]. Pure tone audiometry was scored as 0 (≥50 dB), 0.5 (35–49 dB), or 1 (≤34 dB) based on the average hearing threshold ([500 Hz hearing value + 2 × 1000 Hz hearing value + 2 × 2000 Hz hearing value + 4000 Hz hearing value]/6) in the better ear (using an assistive device) [21]. The psychological domain was assessed using the Korean version of the Short Form Geriatric Depression Scale [22] and was scored as 0 (10–15 points), 1 (6–9 points), or 2 (0–5 points) [23,24].

2.4. Covariates

Covariates were derived from the baseline data (2016). The demographic characteristics included age, educational level, and marital status. Chronic diseases that physicians diagnosed included diseases of the circulatory system, musculoskeletal system and its connective tissue, respiratory, digestive, endocrine, nervous, and urogenital systems, as well as neoplasms, and they were categorized as 0, 1, and ≥2. The following were included in the list of health behaviors: current smoking, recommended physical activity (≥75 min/week of vigorous or ≥150 min/week of moderate-intensity aerobic physical activity) [25], dietary supplement use, and energy intake.

2.5. Statistical analysis

Baseline characteristics, IC, and sub-domain scores were presented as mean ± SD for continuous variables and as number (%) for categorical variables. Independent *t*-tests and chi-square tests were used to evaluate differences in characteristics by sex and between participants included and excluded from the analysis. Gender-specific analyses were performed because prior research indicated gender differences in the association between diet and health [26,27]. A generalized estimating equation (GEE) was used to examine the longitudinal association between dietary patterns, IC, and subdomain scores after controlling for covariates. When using GEE, cluster 2 was used as a reference for men and cluster 3 for women. Both of these groups consumed more rice and kimchi than the other two groups. The beta coefficients (ß), 95% confidence interval (CI), and P-values were calculated. The reported P-values were two-sided, and the significance level was set at less than 0.05.

Sensitivity analysis was also performed. To address missing values, multiple imputations were performed using a standard, fully conditional specification [28]. Five imputed datasets were created using the predictive mean matching method, which considered age, educational level, and marital status [29], and pooled estimates were derived. SPSS for Windows (version 25.0; IBM Corp., Armonk, NY) was used for all the statistical analyses.

3. Results

At baseline, 1558 participants were enrolled in this study. We excluded 133 enrollees whose baseline information and IC were lacking and 760 enrollees who had no baseline dietary data. Finally, we included 665 enrollees with a 6-year follow-up period. In 2018, 2020, and 2022, 24.5%, 22.4%, and 14.4% of all enrollees, respectively, were lost to follow-up or had no information on IC at each annual visit. The research flowchart is presented in Fig. 1.

Table 2 shows the baseline characteristics of the 665 participants. Men accounted for 48.0% of the total sample. The mean age of the participants was 76.2 years (SD 4.0) and the mean IC score was 8.41 (SD 1.37). Men had higher educational levels, were married, had fewer chronic diseases, higher current smoking, recommended physical activity, lower dietary supplement use, higher energy intake, and lower cognitive and higher psychological domains than women ($p < 0.05$). Age, educational level, marital status, recommended physical activity, energy intake, IC score, IC score group, and IC sub-domains differed between non-dropouts and dropouts at baseline (Supplementary Table S1). These differences were similar in both men and women (Supplementary Tables S2 and S3).

Table 3 shows the changes in IC and sub-domain scores based on dietary patterns in men. In the crude model, there were significant associations between dietary patterns and IC score, IC score group, cognitive domain, locomotor domain, and psychological domain. Even after adjusting for confounders, compared with cluster 2 (rice and kimchi), cluster 1 (variety of healthy foods and alcohols) showed a positive association with changes in the IC score (ß = 0.41, *P*-value = 0.030, 95% CI = 0.04–0.78). However, there were no significant associations between dietary patterns and the IC subdomains.

Table 4 shows the changes in IC and sub-domain scores based on dietary patterns in women. In the crude model, there were significant associations between dietary patterns and IC score, IC score group, locomotor domain, and psychological domain. Even after adjusting for confounders, compared with cluster 3 (rice, vegetables, and kimchi), cluster 1 (variety of healthy foods) showed a positive association with changes in the IC score (ß = 0.30, *P*-value = 0.034, 95% CI = 0.02–0.58), IC score group (ß = 0.11, *P*-value = 0.023, 95% CI = 0.02–0.20), and psychological domain (ß = 0.25, *P*-value<0.001, 95% CI = 0.11–0.38). However, there were no significant associations between dietary patterns and other IC subdomains.

Additional sensitivity analysis showed that the results after replacing missing values were weakened in men and were similar in women (Supplementary Tables S4 and S5).

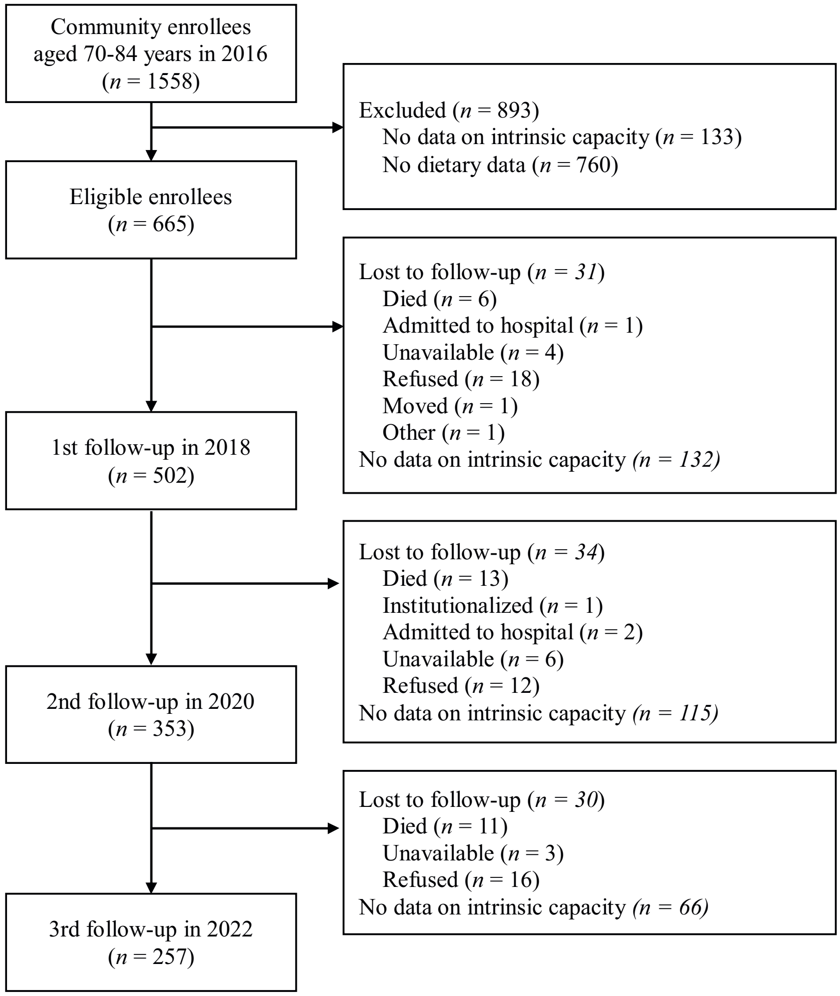

Fig. 1. The research flowchart.

4. Discussion

In a 6-year longitudinal study, the dietary patterns of cluster 1 (variety of healthy foods and alcohols) compared to those of cluster 2 (rice and kimchi) were positively associated with changes in the IC score in older men, with adjusted confounding variables. Although the cluster 1 pattern consisted of healthy (fruits, meats, eggs, milks) and unhealthy food groups (alcohols), the composition of carbohydrate (62.4% of energy), protein (16.4% of energy), and fat (21.2% of energy) intake agreed with the acceptable macronutrient distribution range (AMDR) in older adults (55–65% carbohydrate, 7–20% protein, and 15–30% fat) [30]. In older women, the dietary pattern of cluster 1 (variety of healthy foods) compared to that of cluster 3 (rice, vegetables, and kimchi) was positively associated with changes in the IC score, IC score group, and psychological domain, with adjusted confounding variables. Cluster 1 showed carbohydrate (63.4% of energy), protein (15.7% of energy), and fat (20.9% of energy) intake within the acceptable range of the AMDR [30].

This study findings were similar to the results of a 3-year longitudinal study of older Japanese adults, which found that adherence to "fruit and vegetable" and "protein-rich" patterns was associated with higher IC [11]. A cross-sectional study targeting older Chinese adults also found that high dietary diversity was a protective factor against IC [31]. Moreover, the positive association between dietary patterns and the psychological domain in older women found in this study was also reported in a cross-sectional study of older Chinese adults living in Hong Kong [12]. In contrast, in older Chinese women, dietary patterns were not associated with IC, whereas in older men, various dietary patterns were associated with IC and its sub-domains (locomotor and sensory). Sample characteristics, dietary pattern classification techniques, and IC composition and measurement may have caused discrepancies in the results.

Numerous mechanisms may explain the positive role of diet in increasing IC. According to a literature review, a healthy diet for older adults consists of abundant plant-based foods, adequate protein-rich foods, and healthy fats [10]. Healthy diets may have antioxidant or anti-inflammatory properties or favor microbial diversity [32–34] and may delay the aging process caused by oxygen-free radicals, declining antioxidant defenses, sustained systemic inflammation, or microbiota dysbiosis [35,36].

The dietary patterns of cluster 3 (rice, pulses, vegetables, fishes and shellfishes) compared to those of cluster 2 (rice and kimchi) were not significantly associated with changes in the IC score in older men. In older women, the dietary pattern of cluster 2 (noodles and dumplings, fishes and shellfishes) compared to that of cluster 3 (rice, vegetables, and kimchi) was not significantly associated with changes in the IC score. Both clusters showed higher carbohydrate intakes (65.8% and 73.9% of energy for the respective cluster 3 and cluster 2 in men, and 68.1% and 72.4% of energy for the respective cluster 2 and cluster 3 in women) outside the acceptable range of the AMDR [30]. These may have led to the lack of significant association between dietary patterns and changes in IC scores in both older men and women.

We did not find any association between dietary patterns and cognitive, vitality, locomotor, or sensory domains. There are various domains of cognitive functioning, such as sensation and perception, motor skills and construction, attention and concentration, memory, executive functioning, processing speed, and language/verbal skills [37]. Diets affect specific domains of cognitive function such as memory in

Table 2
Baseline characteristics of all participants.

	Total (*n* = 665)	Men (*n* = 319)	Women (*n* = 346)	*P*-value[a]
Age (years)	76.2 ± 4.0	76.5 ± 3.9	76.0 ± 4.0	0.075
Educational level				
<Middle school	304 (45.7)	97 (30.4)	207 (59.8)	<0.001
≥Middle school	361 (54.3)	222 (69.6)	139 (40.2)	
Marital status				
Others	223 (33.5)	40 (12.5)	183 (52.9)	<0.001
Married	442 (66.5)	279 (87.5)	163 (47.1)	
Number of physician-diagnosed chronic diseases				
0	88 (13.2)	51 (16.0)	37 (10.7)	0.003
1	140 (21.1)	79 (24.8)	61 (17.6)	
≥2	437 (65.7)	189 (59.2)	248 (71.7)	
Current smoking				
No	630 (94.7)	286 (89.7)	344 (99.4)	<0.001
Yes	35 (5.3)	33 (10.3)	2 (0.6)	
Recommended physical activity[b]				
No	387 (58.2)	172 (53.9)	215 (62.1)	0.032
Yes	278 (41.8)	147 (46.1)	131 (37.9)	
Dietary supplement use				
No	250 (37.6)	136 (42.6)	114 (32.9)	0.010
Yes	415 (62.4)	183 (57.4)	232 (67.1)	
Energy intake (kcal)	1425.4 ± 403.9	1602.1 ± 386.9	1262.5 ± 347.2	<0.001
Intrinsic capacity score	8.41 ± 1.37	8.41 ± 1.33	8.40 ± 1.41	0.932
Intrinsic capacity score (group)	1.56 ± 0.52	1.56 ± 0.51	1.55 ± 0.53	0.939
Cognitive domain	1.81 ± 0.53	1.73 ± 0.62	1.89 ± 0.42	<0.001
Locomotor domain	1.46 ± 0.50	1.48 ± 0.50	1.45 ± 0.50	0.461
Vitality domain	1.86 ± 0.37	1.86 ± 0.37	1.85 ± 0.37	0.825
Sensory domain	1.60 ± 0.55	1.57 ± 0.54	1.62 ± 0.56	0.237
Psychological domain	1.68 ± 0.64	1.77 ± 0.55	1.59 ± 0.70	<0.001

Values are presented as mean ± standard deviation or number (percentage).
[a] Independent *t*-test for continuous variables and chi-square test for categorical variables.
[b] ≥75 min/week of vigorous- or ≥150 min/week of moderate-intensity aerobic physical activity [25].

Table 3
Changes in the intrinsic capacity and sub-domain scores by dietary pattern groups in men.

	Crude model				Adjusted model[a]			
	GEE ß	*P*-value	95% CI		GEE ß	*P*-value	95% CI	
			Lower limit	Upper limit			Lower limit	Upper limit
Intrinsic capacity score								
Cluster 1	0.62	0.001	0.26	0.98	0.41	0.030	0.04	0.78
Cluster 3	0.50	0.004	0.16	0.84	0.32	0.075	−0.03	0.68
Cluster 2	Ref.				Ref.			
Intrinsic capacity score (group)								
Cluster 1	0.18	0.004	0.06	0.30	0.11	0.094	−0.02	0.24
Cluster 3	0.08	0.192	−0.04	0.20	0.03	0.650	−0.10	0.15
Cluster 2	Ref.				Ref.			
Cognitive domain								
Cluster 1	0.19	0.024	0.03	0.36	0.16	0.096	−0.03	0.34
Cluster 3	0.20	0.013	0.04	0.36	0.16	0.063	−0.01	0.34
Cluster 2	Ref.				Ref.			
Locomotor domain								
Cluster 1	0.14	0.019	0.02	0.25	0.07	0.217	−0.04	0.19
Cluster 3	0.04	0.464	−0.07	0.15	−0.01	0.871	−0.12	0.10
Cluster 2	Ref.				Ref.			
Vitality domain								
Cluster 1	0.01	0.897	−0.08	0.09	−0.01	0.832	−0.10	0.08
Cluster 3	0.01	0.792	−0.07	0.09	0.01	0.893	−0.08	0.09
Cluster 2	Ref.				Ref.			
Sensory domain								
Cluster 1	0.03	0.638	−0.10	0.17	0.00	0.950	−0.15	0.14
Cluster 3	0.08	0.256	−0.06	0.21	0.05	0.489	−0.09	0.18
Cluster 2	Ref.				Ref.			
Psychological domain								
Cluster 1	0.16	0.029	0.02	0.31	0.13	0.088	−0.02	0.29
Cluster 3	0.14	0.052	0.00	0.28	0.11	0.128	−0.03	0.26
Cluster 2	Ref.				Ref.			

Abbreviations: GEE, generalized estimating equation; CI, confidence interval; Ref., reference.
[a] Adjusted for age, educational level, marital status, number of physician-diagnosed chronic diseases, current smoking, physical activity, dietary supplement use, and energy intake.

Table 4
Changes in the intrinsic capacity score and sub-domain scores by dietary pattern groups in women.

	Crude model				Adjusted model[a]			
	GEE ß	*P*-value	95% CI		GEE ß	*P*-value	95% CI	
			Lower limit	Upper limit			Lower limit	Upper limit
Intrinsic capacity score								
Cluster 1	0.62	<0.001	0.33	0.91	0.30	0.034	0.02	0.58
Cluster 2	0.28	0.139	−0.09	0.66	0.11	0.537	−0.24	0.46
Cluster 3	Ref.				Ref.			
Intrinsic capacity score (group)								
Cluster 1	0.21	<0.001	0.12	0.30	0.11	0.023	0.02	0.20
Cluster 2	0.07	0.294	−0.06	0.20	0.02	0.754	−0.10	0.14
Cluster 3	Ref.				Ref.			
Cognitive domain								
Cluster 1	−0.01	0.696	−0.09	0.06	−0.02	0.586	−0.10	0.05
Cluster 2	0.03	0.531	−0.06	0.12	0.03	0.539	−0.06	0.11
Cluster 3	Ref.				Ref.			
Locomotor domain								
Cluster 1	0.18	<0.001	0.09	0.27	0.08	0.070	−0.01	0.17
Cluster 2	0.02	0.737	−0.10	0.15	−0.03	0.588	−0.14	0.08
Cluster 3	Ref.				Ref.			
Vitality domain								
Cluster 1	0.05	0.127	−0.02	0.12	0.03	0.342	−0.04	0.10
Cluster 2	0.04	0.313	−0.04	0.13	0.03	0.500	−0.06	0.11
Cluster 3	Ref.				Ref.			
Sensory domain								
Cluster 1	0.09	0.099	−0.02	0.20	0.02	0.724	−0.09	0.13
Cluster 2	0.02	0.775	−0.14	0.18	−0.01	0.873	−0.16	0.14
Cluster 3	Ref.				Ref.			
Psychological domain								
Cluster 1	0.37	<0.001	0.24	0.51	0.25	<0.001	0.11	0.38
Cluster 2	0.19	0.041	0.01	0.37	0.11	0.212	−0.06	0.28
Cluster 3	Ref.				Ref.			

Abbreviations: GEE, generalized estimating equation; CI, confidence interval; Ref., reference.
[a] Adjusted for age, educational level, marital status, number of physician-diagnosed chronic diseases, current smoking, physical activity, dietary supplement use, and energy intake.

general, episodic memory, and processing speed [38]. The association with dietary patterns may differ depending on cognitive function domains. Nutritional status, handgrip strength, and plasma biomarker levels were acceptable measurements of vitality in a recent study [39]. In this study, we measured vitality using the MNA-SF, which reflects nutritional status, but did not obtain significant results. This may be due to the involvement of hormones and cardiorespiratory fitness, which affect energy metabolism [40] or self-perceived fatigue, muscle endurance, and body composition [41]. Previous studies have reported no significant association between dietary patterns and locomotion (using the six-meter walking test, timed chair stand test, and dynamic balance) in older Chinese women [12]. Previous longitudinal studies have reported no association between diet quality, concurrent vision, and hearing impairment [42]. Further studies are required to confirm these findings.

This study had several limitations. First, dietary data were obtained using a 24-h dietary recall. This method makes it difficult to reflect the usual intake of study participants. However, we calculated the mean intake by examining the dietary intake for two nonconsecutive days. Second, dietary patterns were strongly associated with the diet of the study population; thus, the results of this study may not be generalizable to other populations. Third, although many potential confounders were included, residual confounding factors may have remained. Finally, the high dropout rate during the follow-up may have compromised the robustness of our results. To minimize uncertainty in the inferences from our findings, we used multiple imputation methods and obtained pooled estimates. The consistency and stability of the results were maintained in women, but weakened in men. Those who were excluded due to missing data at follow-up had significantly lower energy intake and IC scores than those of the participants (Supplementary Tables S1 and S3). This selection bias may have underestimated the associations between dietary patterns and IC.

5. Conclusions

This study showed that the dietary patterns of cluster 1 (variety of healthy foods and alcohols), compared to cluster 2 (rice and kimchi), were positively associated with changes in the IC score in older men. In older women, compared to cluster 3 (rice, vegetables, and kimchi), the dietary pattern of cluster 1 (variety of healthy foods) was positively associated with changes in the IC score, IC score group, and psychological domain. Further research is required to determine the longitudinal association between dietary patterns and IC, especially in populations from different cultures.

Authors' contributions

Conceptualization, J.K., Y.L., M.K., C.W.W., and M.K.K.; methodology, J.K. and J.S.S.; formal analysis, J.K. and J.-S.S.; resources, M.K.K.; writing-original draft preparation, J.K.; writing-review & editing, Y.L.; supervision, Y.L., M.K., C.W.W., and M.K.K.; funding acquisition, C.W.W. and M.K. All authors have read and agreed to the published version of the manuscript.

Ethics approval and consent to participate

The Institutional Review Board of Ajou University Hospital approved this study (AJOUIRB-DB-2024-044), which was conducted in accordance with the guidelines of the Declaration of Helsinki. All participants provided written informed consent.

Availability of data and materials

As our data are not yet publicly available, we choose to exclude this statement.

Competing interests

The authors declare that they have no competing interests.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.jnha.2024.100314.

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