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Dietary patterns and their associations with health behaviours in Korea

Eo Rin Cho[1,2,3], Aesun Shin[1,*], Sun-Young Lim[1] and Jeongseon Kim[1]
[1]Cancer Epidemiology Branch, Division of Cancer Epidemiology and Management, Research Institute, National Cancer Center, 323 Ilsan-ro, Ilsandong-gu, Goyang-si, Gyeonggi-do 410-769, Republic of Korea: [2]Department of Public Health, The Graduate School, Yonsei University, Republic of Korea: [3]Institute of Human Genomic Study, College of Medicine, Korea University, Seoul, Republic of Korea

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Abstract

Objective: Dietary habits, including dietary patterns, have been associated with the risk of chronic diseases, including cancer. The objective of the present study was to evaluate Korean dietary patterns as assessed by using an FFQ and associations of dietary patterns with lifestyle risk factors.
Design: Dietary patterns were analysed by factor analysis using a sixteen-group FFQ. The associations between dietary patterns and lifestyle risk factors were investigated by logistic regression analysis.
Setting: The National Cancer Center in South Korea.
Subjects: The study population included 11 440 participants aged ≥30 years who were recruited between 2002 and 2007.
Results: Compared with the lowest quartile intake of each dietary pattern, current smoking was positively associated with the Western pattern (OR = 1·55 for the highest quartile, 95 % CI 1·27, 1·88; $P < 0·001$) and the traditional pattern (OR = 1·34, 95 % CI 1·11, 1·62; $P = 0·002$) in men, but was inversely associated with the healthy pattern in both genders ($P < 0·001$) and the traditional pattern (OR = 0·52, 95 % CI 0·36, 0·75; $P = 0·001$) in women. Alcohol consumption was positively associated with all patterns in both genders, while no association was observed with the healthy pattern in women. Physical activity and dietary supplement use were positively associated with all patterns in both genders, with the exception of physical activity in women, which showed an inverse association with the traditional pattern.
Conclusions: Dietary patterns are strongly associated with health behaviours. The possible confounding effect of other risk behaviours should be appropriately considered when conducting nutritional epidemiological studies.

Keywords
Factor analysis
Dietary patterns
Health behaviour

Although traditionally nutritional research has focused primarily on single nutrients or individual foods, interest is growing in dietary patterns that consider the complexity of the overall diet[1,2]. An exploratory approach using factor or cluster analysis empirically identifies patterns that represent actual eating behaviours of the study population. Typically, analyses extract two to six patterns that reflect different dietary compositions[3].

Recently, several experimental, clinical and epidemiological studies have examined dietary patterns and found that patterns reflecting certain eating habits are associated with the risk of chronic diseases[2,4–7], including cancer[8,9]. Dietary habits are also closely related to other health-related behaviours. Current smoking is generally inversely related to a healthy diet[10–13]; alcohol consumption is positively related to diets with high intakes of fat and meat, but inversely related to a prudent diet[14–17]; and dietary supplement use is often associated with a healthy diet that reflects high intakes of skimmed milk, yoghurt, juice, cereals, rice, chicken, fruit and cod liver oil[11,18,19]. However, most studies of these factors have been conducted in North America or Europe, whereas only a few studies have investigated Asian populations[15,20], and the results may not apply to the Korean population whose dietary habits are different from patterns in Western countries.

Thus, the purpose of the present study was to evaluate Korean dietary patterns by using an FFQ and to assess the association of dietary patterns with lifestyle risk factors, such as smoking, alcohol consumption, physical activity and dietary supplement use.

Experimental methods

Study participants

The source population comprised 14 531 men and women who underwent cancer screening examinations at

*Corresponding author: Email shina@ncc.re.kr

the Center for Cancer Prevention and Detection at the National Cancer Center in South Korea from August 2002 to May 2007. Participants who failed to complete information for all sixteen food groups in the FFQ or who were <30 years of age were excluded. After these exclusions, 11 440 participants (6434 men and 5006 women) remained for the analyses. Written informed consent was obtained from all participants, and all procedures were approved by the Institutional Review Board of the National Cancer Center.

Data collection

All participants were asked to complete a self-administered questionnaire about their sociodemographic characteristics (e.g. age, education and household income), cigarette smoking habit, alcohol consumption habit, physical activity, dietary supplement use, personal medical history and medication use. The average alcohol consumption amount (g/d) was calculated by summing the beverage-specific amount consumed as reported on the FFQ, average consumption frequency and the volume of one standard drink for each type of alcoholic beverage (beer, hard liquor, wine and traditional drinks, including *soju* and Korean rice wine).

At the time of screening, for each participant, height and weight were measured using the InBody 3·0 (Biospace, Seoul, Korea) body composition analyser, and BMI was calculated as weight (kg) divided by the square of height (m^2). Three categories were constructed for smoking habits (non-, ex- and current) and alcohol consumption (non-, light and heavy), and two categories each were constructed for participation in leisure-time physical activity, dietary supplement use and past medical history of hypertension and diabetes (yes or no).

Dietary pattern derivation

Dietary information was collected using an FFQ. The FFQ consisted of sixteen food groups: cereals, salted vegetables and seafood, light-coloured vegetables, green-yellow vegetables, seaweeds, fruits, grilled meat and seafood, healthy protein foods, dairy products, bonefish, fried foods, cholesterol-rich foods, animal fat-rich foods, sweet foods, fast foods and caffeinated drinks (see Appendix). All participants were asked to record their current intake frequency for each food group according to the following categories: consumed rarely, once monthly, 2–3 times/month, once weekly, 2–3 times/week, 4–6 times/week, once daily or >2 times/d. In our previous study, the validity of this FFQ was compared to the 3 d dietary record method as a reference standard for 1401 participants from the source cohort. The cross-classification of the tertile categories by using these two methods showed good agreement (range: 38–96 %, depending on the food group). Generally, there was a trend that participants who reported a high frequency of intake on the brief FFQ also reported a high amount of intake of food in the 3 d dietary records. The highest agreement was observed for cereals (68·7 %), dairy foods (59·1 %), fruits (55·6 %) and caffeinated drinks (61·8 %)[21].

Statistical analyses

Dietary patterns were derived by using factor analysis, with the sixteen food groups entered into the analysis by the frequency of intake. The PROC FACTOR procedure in the SAS statistical software package version 9·1 (SAS Institute, Cary, NC, USA) was applied to perform the analysis. This procedure uses factor analysis and orthogonal rotation, using the Varimax option in SAS, to derive non-correlated factors and to render the results more easily interpretable. To determine which number of factors to retain, we examined both the scree plots and the factors themselves to see which set of factors most meaningfully described distinct food intake patterns. We considered components with an eigenvalue of >1·0. This served to limit the number of factors, as well as to better identify the three most meaningful factors. Factor loadings were calculated for each food group across the three factors. Factors were thereby interpreted as dietary patterns and named after the food groups with a loading of >0·2. A dietary factor score for each individual was then calculated by summing the consumption of food groups weighted by the factor loadings.

Dietary factor scores were categorized into quartiles separately for men and women based on the distribution of the study population, and linear regression analysis was performed to evaluate the association between dietary pattern categories and health behaviour variables with adjustments for age. *P* for trend was calculated from generalized linear models with adjustments for age as a continuous variable and from Mantel–Haenszel χ^2 tests with adjustments for age group as a categorical variable. To assess associations between dietary patterns and health behaviours, polytomous multiple logistic regression models were used to calculate the OR and 95 % CI for each quartile. *P* for trend in the OR was calculated with the dietary pattern categories as a continuous variable. Analyses were conducted using the SAS software version 9·1 (SAS Institute). All analyses were performed separately for men and women, and a two-sided *P* value of <0·05 was considered to be statistically significant.

Results

Among men and women aged ≥30 years who were recruited between 2002 and 2007 from the National Cancer Center in South Korea, 11 440 participants were included in the final analysis (6434 men and 5006 women). Table 1 shows the three main dietary patterns and the factor-loading matrix between food groups. The larger the loading of a given food group to the factor, the greater the contribution of that food group to a specific factor. Dietary pattern 1 was characterized by high consumption of fast foods, animal fat-rich foods, fried foods, grilled

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Table 1 Factor-loading matrix for the major dietary patterns identified by factor analysis

	Men (*n* 6434)			Women (*n* 5006)		
	Pattern 1 (Western)	Pattern 2 (healthy)	Pattern 3 (traditional)	Pattern 1 (Western)	Pattern 2 (healthy)	Pattern 3 (traditional)
Fast foods	0·70			0·72		
Animal fat-rich foods	0·67			0·71		
Fried foods	0·66	0·22		0·61	0·21	
Grilled meat and seafood	0·59			0·54		
Cholesterol-rich foods	0·53	0·33		0·51	0·33	
Sweet foods	0·51			0·54		
Caffeinated drinks	0·27			0·35		
Green-yellow vegetables		0·64	0·28		0·58	0·30
Seaweeds		0·58			0·55	0·21
Healthy protein foods		0·56			0·58	
Bonefish		0·53			0·54	
Fruits		0·48			0·47	
Dairy products		0·31			0·34	
Salted vegetables and seafood			0·63			0·66
Cereals			0·58			0·60
Light-coloured vegetables		0·43	0·55		0·38	0·56

For the sake of simplicity, factor loadings of <0·20 are not listed.

meat and seafood (barbecue), cholesterol-rich foods, sweet foods and caffeinated drinks. We named this pattern the 'Western pattern'. Dietary pattern 2 was characterized by high consumption of green-yellow vegetables, seaweeds, healthy protein foods, bonefish, fruit and dairy products, and we named this pattern the 'healthy pattern'. Dietary pattern 3 was characterized by high consumption of salted vegetables and seafood, cereals and light-coloured vegetables, and we named this pattern the 'traditional pattern'. The major dietary patterns identified separately for men and women proved to be similar. Each of the three patterns explained 15·3%, 13·0% and 7·8% of variance of food frequency consumption in men and 15·3%, 12·2% and 8·3% in women, respectively.

Demographic characteristics and lifestyle factors are presented as means (SD) or numbers and percentages stratified by quartiles of factor scores for each dietary pattern (Table 2). Among both men and women, participants with a higher healthy dietary pattern score tended to have a higher educational level and household income, to smoke less and to report more physical activity and dietary supplement use. Participants with a higher Western dietary pattern score were younger and more likely to smoke and drink, and men were more likely to have a higher BMI. Participants with a higher traditional dietary pattern score were more likely to have a higher educational level and household income and to be involved in regular leisure-time physical activity.

The results of multivariate logistic regression analyses of the association between dietary patterns and health behaviours such as smoking, alcohol consumption, regular exercise and dietary supplement use are presented in Table 3 for men and in Table 4 for women. Current smoking was positively associated with the Western dietary pattern (*P* for trend <0·001) and the traditional dietary pattern (*P* for trend = 0·002) in men. However, current smoking was inversely associated with the healthy dietary pattern in both genders (*P* for trend <0·001) and with the traditional dietary pattern (*P* for trend = 0·001) in women. Alcohol consumption was positively associated with all patterns in men, with the exception of light drinking, which was inversely associated with the Western dietary pattern (*P* for trend = 0·044). In women, heavy drinking was positively associated with the Western dietary pattern (*P* for trend = 0·007), and light drinking was positively associated with the traditional dietary pattern (*P* for trend = 0·001), while there was no association observed with the healthy pattern. Physical activity and dietary supplement use were positively associated with all patterns in both genders, with the exception of physical activity, which was inversely associated with the traditional dietary pattern in women.

Discussion

In the present study of Korean adults, we identified three major dietary patterns, Western, healthy and traditional, and we evaluated their relationship with health behaviours. The three dietary patterns identified in the present study were similar to the dietary patterns found by previous studies conducted among Asian and Western populations using factor analysis[10,14,15,22].

The Western pattern and the healthy pattern (or 'prudent pattern') have been reported by many other studies. The main contributors to the Western dietary pattern are typically meats, fats, fast food, sweets, grains, butter, eggs, potatoes and sugar-containing foods[8,23,24]. The main contributors to the healthy pattern are vegetables, fruit, fish and poultry[9,12,23–26]. Several studies have also reported a traditional

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Table 2 Characteristics of study participants according to quartiles of factor scores for each pattern

	Men					Women				
	Quartile 1 (*n* 1608)		Quartile 4 (*n* 1609)			Quartile 1 (*n* 1251)		Quartile 4 (*n* 1252)		
	n	%	*n*	%	*P* for trend*	*n*	%	*n*	%	*P* for trend*
Western pattern										
Age (years)†	53·12	9·30	44·52	9·20	<0·001	53·06	8·55	43·08	8·56	<0·001
BMI (kg/m^2)†	24·38	2·58	24·86	2·94	<0·001	23·55	3·00	22·50	2·92	0·916
Education level										
Middle or less	240	15·09	78	4·87	<0·001	414	33·91	107	8·60	<0·001
High school	524	32·96	375	23·39		502	41·11	420	33·76	
College or more	826	51·95	1150	71·74		305	24·98	717	57·64	
Household income‡										
<2000	285	20·26	110	7·71	<0·001	298	30·19	130	12·25	<0·001
2000–3999	481	34·19	491	34·43		340	34·45	343	32·33	
>4000	641	45·56	825	57·85		349	35·36	588	55·42	
Smoking										
Non-smokers	407	25·78	279	17·49	<0·001	946	92·93	982	88·31	0·001
Ex-smokers	584	36·99	445	27·90		20	1·96	43	3·87	
Current smokers	588	37·24	871	54·61		52	5·11	87	7·82	
Alcohol consumption	197	17·30	153	12·91	<0·001	658	66·53	487	48·99	<0·001
Non-drinkers (0 g/d)										
Light drinkers (<12 g/d)	401	35·21	289	24·39		291	29·42	415	41·75	
Heavy drinkers (≥12 g/d)	541	47·50	743	62·70		40	4·04	92	9·26	
Physical activity										
No	546	38·78	461	30·63	<0·001	538	52·85	577	51·52	0·742
Yes	862	61·22	1044	69·37		480	47·15	543	48·48	
History of hypertension§										
No	1241	77·18	1404	87·26	<0·001	1024	81·85	1166	93·13	<0·001
Yes	367	22·82	205	12·74		227	18·15	86	6·87	
History of diabetes‡										
No	1439	89·49	1517	94·28	<0·001	1166	93·21	1231	98·32	<0·001
Yes	169	10·51	92	5·72		85	6·79	21	1·68	
Dietary supplement use										
No	1099	68·35	1095	68·06	0·708	701	56·04	715	57·11	0·347
Yes	509	31·65	514	31·95		55	43·96	537	42·89	
Healthy pattern										
Age (years)†	47·15	9·87	50·22	9·64	<0·001	47·01	9·65	49·37	9·27	<0·001
BMI (kg/m^2)†	24·49	2·77	24·57	2·67	0·229	23·08	3·11	23·03	2·86	0·009
Education level										
Middle or less	217	13·62	112	7·02	<0·001	362	29·43	186	15·11	<0·001
High school	516	32·39	364	22·81		506	41·14	471	38·26	
College or more	860	53·99	1120	70·18		362	29·43	574	46·63	
Household income‡										
<2000	288	19·81	113	8·11	<0·001	271	26·06	134	13·35	<0·001
2000–3999	551	37·90	429	30·77		353	33·94	349	34·76	
>4000	615	42·30	852	61·12		416	40·00	521	51·89	
Smoking										
Non-smokers	284	17·94	380	24·11	<0·001	950	87·96	983	93·26	<0·001
Ex-smokers	488	30·83	564	35·79		36	3·33	24	2·28	
Current smokers	811	51·23	632	40·10		94	8·70	47	4·46	
Alcohol consumption										
Non-drinkers (0 g/d)	177	16·48	156	12·77	0·151	492	53·36	613	58·55	0·016
Light drinkers (<12 g/d)	309	28·77	381	31·18		354	38·39	366	34·96	
Heavy drinkers (≥12 g/d)	588	54·75	685	56·06		76	8·24	68	6·49	
Physical activity										
No	662	45·88	411	27·92	<0·001	651	61·71	465	43·70	<0·001
Yes	781	54·12	1061	72·08		404	38·29	599	56·30	
History of hypertension§										
No	1363	84·76	1297	80·66	<0·001	1093	87·37	1086	86·81	0·612
Yes	245	15·24	311	19·34		158	12·63	165	13·19	
History of diabetes‡										
No	1514	94·15	1459	90·73	<0·001	1205	96·32	1197	95·68	0·382
Yes	94	5·85	149	9·27		46	3·68	54	4·32	
Dietary supplement use										
No	1230	76·49	1001	62·25	<0·001	804	64·27	606	48·44	<0·001
Yes	378	23·51	607	37·75		447	35·73	645	51·56	
Traditional pattern										
Age (years)†	49·09	9·92	48·19	9·58	0·017	48·27	9·13	47·93	9·41	0·288
BMI (kg/m^2)†	24·51	2·80	24·45	2·79	0·169	23·15	2·86	23·11	3·20	0·797

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Table 2 *Continued*

	Men					Women				
	Quartile 1 (*n* 1608)		Quartile 4 (*n* 1609)			Quartile 1 (*n* 1251)		Quartile 4 (*n* 1252)		
	n	%	*n*	%	*P* for trend*	*n*	%	*n*	%	*P* for trend*
Education level										
Middle or less	191	12·00	138	8·64	<0·001	324	26·32	246	20·05	<0·001
High school	514	32·29	427	26·74		522	42·40	480	39·12	
College or more	887	55·72	1032	64·62		385	31·28	501	40·83	
Household income‡										
<2000	245	16·98	168	12·03	<0·001	230	22·55	176	17·14	<0·001
2000–3999	508	35·20	484	34·65		380	37·25	332	32·33	
>4000	690	47·82	745	53·33		410	40·20	519	50·54	
Smoking										
Non-smokers	369	23·34	287	18·04	0·001	911	89·40	1023	92·92	0·001
Ex-smokers	474	29·98	499	31·36		28	2·75	31	2·82	
Current smokers	738	46·68	805	50·60		80	7·85	47	4·27	
Alcohol consumption										
Non-drinkers (0 g/d)	182	18·35	159	12·67	<0·001	555	60·52	572	55·21	0·763
Light drinkers (<12 g/d)	299	30·14	380	30·28		284	30·97	407	39·29	
Heavy drinkers (≥12 g/d)	511	51·51	716	57·05		78	8·51	57	5·50	
Physical activity										
No	557	39·12	523	35·51	0·011	517	49·52	588	53·94	0·038
Yes	867	60·88	950	64·49		527	50·48	502	46·06	
History of hypertension§										
No	1338	83·16	1342	83·46	0·506	1105	88·26	1096	87·54	0·612
Yes	271	16·84	266	16·54		147	11·74	156	12·46	
History of diabetes‡										
No	1494	92·85	1498	93·16	0·411	1210	96·65	1200	95·85	0·278
Yes	115	7·15	110	6·84		42	3·35	52	4·15	
Dietary supplement use										
No	1189	73·90	1061	65·98	<0·001	749	59·82	709	56·63	0·081
Yes	420	26·10	547	34·02		503	40·18	543	43·37	

*P for trend was calculated from a generalized linear model with adjustments for age for continuous variables, and a Mantel–Haenszel χ^2 test with adjustments for the age group for categorical variables.
†Age and BMI data are mean and standard deviation.
‡Unit is thousand won (₩)/month.
§Hypertension was defined as the use of antihypertensive medication or a history of hypertension. Diabetes was defined as the use of any diabetes medication or a history of diabetes.

dietary pattern[12,15,20,22,27,28]. In a study of 1441 Korean children, in which thirty-three food groups were created and entered into a factor analysis, the traditional (Korean) pattern included vegetables, seaweeds, beans, fruits, milk and dairy products[20]. A study of the dietary pattern of 637 Korean Americans found that the traditional Korean pattern was characterized by high intake of traditional Korean dishes, such as soyabean paste stew, anchovies, Korean-style grains, *tofu*, vegetables, *kimchi*, salted/fermented fish, seaweeds, Korean-style soups, red meat, other seafood (shrimp, squid, clams, oyster, etc) and fish[22]. In Japan, the traditional pattern includes pickled vegetables, salted fish and roe, fish, rice and *miso* soup[15]. In contrast, in the Netherlands, the traditional pattern is characterized by higher consumption of red meat, potatoes, highly saturated added fats, coffee and beer and lower consumption of soya products, low-fat dairy, breakfast cereals, tea and fruits[27]. A traditional Norwegian dietary pattern consists mainly of two or three similar cold meals, usually open sandwiches, and one hot meal with either fish or meat served with potatoes and vegetables[28]. The traditional dietary pattern in the present study included salted foods, such as pickled vegetables, *kimchi* and rice.

Studies of dietary patterns conducted in other populations have noted the importance of evaluating associations of dietary patterns with health behaviours, such as smoking, alcohol consumption, physical activity and dietary supplement use. For smoking, our study found that current smoking was strongly associated with the traditional and Western dietary patterns in men, but was inversely associated with the healthy pattern in both genders. In general, previously conducted studies have found that current smoking is inversely related to a healthy dietary pattern[11,12], whereas former smokers tend to have a healthier dietary pattern[29]. For example, in a population-based Dutch study of 4244 men, men who smoked >20 cigarettes/d had significantly lower intake of β-carotene and especially ascorbic acid compared with men who never smoked, which was attributed to an almost 60 % lower fruit intake among smokers[30]. The European Prospective Investigation into Cancer and Nutrition (EPIC)–Potsdam study found that the 'fruit and vegetable' dietary pattern was negatively associated with smoking ($\beta = -0{\cdot}188$ in men and $-0{\cdot}225$ in women)[10]. The Monitoring of Trends and Determinants

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Table 3 Dietary patterns according to lifestyle risk factors (smoking, alcohol consumption, physical activity and dietary supplement use status), by polytomous logistic regression analysis, in men

	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	*P* for trend*
Western pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	1·27	1·05, 1·54	1·13	0·93, 1·37	1·22	0·99, 1·49	0·127
Current smokers	1	Ref.	1·46	1·21, 1·76	1·22	1·01, 1·47	1·55	1·27, 1·88	<0·001
Alcohol consumption†									
Non-drinkers									
Light drinkers	1	Ref.	1·12	0·86, 1·45	0·94	0·72, 1·23	0·77	0·58, 1·02	0·044
Heavy drinkers	1	Ref.	1·27	1·00, 1·63	1·34	1·05, 1·73	1·28	1·00, 1·65	0·053
Physical activity									
No									
Yes	1	Ref.	1·16	1·00, 1·35	1·39	1·19, 1·63	1·61	1·37, 1·90	<0·001
Dietary supplement use									
No									
Yes	1	Ref.	1·11	0·95, 1·29	1·26	1·08, 1·47	1·30	1·11, 1·52	<0·001
Healthy pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	0·89	0·73, 1·10	0·88	0·72, 1·08	0·84	0·69, 1·02	0·098
Current smokers	1	Ref.	0·84	0·69, 1·01	0·85	0·70, 1·03	0·66	0·54, 0·79	<0·001
Alcohol consumption†									
Non-drinkers									
Light drinkers	1	Ref.	1·34	1·02, 1·74	1·25	0·96, 1·63	1·49	1·14, 1·94	0·009
Heavy drinkers	1	Ref.	1·36	1·06, 1·74	1·35	1·06, 1·72	1·58	1·24, 2·04	0·001
Physical activity									
No									
Yes	1	Ref.	1·50	1·29, 1·74	2·05	1·76, 2·39	2·16	1·86, 2·53	<0·001
Dietary supplement use									
No									
Yes	1	Ref.	1·53	1·31, 1·79	1·66	1·42, 1·94	1·85	1·59, 2·16	<0·001
Traditional pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	1·26	1·04, 1·53	1·30	1·07, 1·58	1·36	1·12, 1·66	0·003
Current smokers	1	Ref.	0·97	0·81, 1·17	1·02	0·85, 1·22	1·34	1·11, 1·62	0·002
Alcohol consumption†									
Non-drinkers									
Light drinkers	1	Ref.	1·43	1·10, 1·86	1·33	1·02, 1·73	1·44	1·11, 1·87	0·028
Heavy drinkers	1	Ref.	1·43	1·12, 1·83	1·64	1·28, 2·09	1·54	1·21, 1·97	<0·001
Physical activity									
No									
Yes	1	Ref.	1·26	1·08, 1·46	1·48	1·27, 1·72	1·17	1·01, 1·37	0·009
Dietary supplement use									
No									
Yes	1	Ref.	1·55	1·33, 1·81	1·43	1·23, 1·67	1·50	1·29, 1·75	<0·001

Ref., reference category.
*Adjusted for age.
†Non-drinkers (0 g/d); light drinkers (<12 g/d); and heavy drinkers (≥12 g/d).

in Cardiovascular Disease (MONICA) population survey of 976 men aged 45–64 years also found a negative association of smoking status ($P < 0·001$) with a healthy dietary pattern[31]. Finally, the Multiethnic Cohort Study of 195 298 participants residing in Hawaii and Los Angeles reported that current smokers showed a positive association with the fat and meat pattern (OR = 1·67, 95 % CI 1·62, 1·72) and inverse associations with the vegetable (OR = 0·66, 95 % CI 0·64, 0·68) and fruit and milk patterns (OR = 0·53, 95 % CI 0·52, 0·55)[14]. Consistent with these findings, another study has shown that smokers are less likely than non-smokers to consume vegetables and milk or dairy foods. Smokers may consume more caffeinated or alcoholic beverages and meat products in order to enhance the taste of smoking[32].

For alcohol consumption, we observed that heavy alcohol consumption was positively associated with the Western pattern in both genders, whereas light alcohol consumption was inversely associated with the Western pattern in men. Among 15 073 university graduates enrolled in the Seguimiento Universidad de Navarra study in Spain, higher adherence to the Western dietary pattern was less likely to decrease participants' alcohol consumption during follow-up, whereas participants with

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Table 4 Dietary patterns according to lifestyle risk factors (smoking, alcohol consumption, physical activity, dietary supplement use status), by polytomous logistic regression analysis, in women

	Quartile 1		Quartile 2		Quartile 3		Quartile 4		
	OR	95 % CI	OR	95 % CI	OR	95 % CI	OR	95 % CI	*P* for trend*
Western pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	1·42	0·80, 2·53	1·06	0·57, 1·96	1·70	0·95, 3·05	0·136
Current smokers	1	Ref.	0·84	0·57, 1·25	0·78	0·53, 1·16	0·94	0·64, 1·38	0·854
Alcohol consumption									
Non-drinkers									
Light drinkers	1	Ref.	0·97	0·80, 1·19	1·11	0·90, 1·36	1·12	0·91, 1·38	0·168
Heavy drinkers	1	Ref.	1·38	0·91, 2·10	1·53	1·01, 2·33	1·79	1·18, 2·72	0·007
Physical activity									
No									
Yes	1	Ref.	1·18	0·99, 1·40	1·16	0·97, 1·39	1·24	1·03, 1·49	0·043
Dietary supplement use									
No									
Yes	1	Ref.	1·21	1·03, 1·43	1·22	1·03, 1·44	1·34	1·12, 1·59	0·002
Healthy pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	0·94	0·59, 1·52	0·69	0·42, 1·16	0·68	0·40, 1·15	0·079
Current smokers	1	Ref.	0·75	0·55, 1·03	0·49	0·34, 0·71	0·54	0·38, 0·78	<0·001
Alcohol consumption									
Non-drinkers									
Light drinkers	1	Ref.	0·77	0·63, 0·94	0·88	0·72, 1·07	0·91	0·75, 1·11	0·708
Heavy drinkers	1	Ref.	0·75	0·53, 1·06	0·57	0·39, 0·84	0·81	0·57, 1·16	0·138
Physical activity									
No									
Yes	1	Ref.	1·42	1·20, 1·69	1·71	1·44, 2·03	2·03	1·70, 2·41	<0·001
Dietary supplement use									
No									
Yes	1	Ref.	1·38	1·17, 1·62	1·43	1·22, 1·68	1·81	1·54, 2·13	<0·001
Traditional pattern									
Smoking									
Non-smokers									
Ex-smokers	1	Ref.	1·16	0·70, 1·93	0·82	0·48, 1·41	0·98	0·58, 1·64	0·609
Current smokers	1	Ref.	0·76	0·54, 1·07	0·70	0·50, 0·99	0·52	0·36, 0·75	0·001
Alcohol consumption									
Non-drinkers									
Light drinkers	1	Ref.	1·12	0·91, 1·37	1·26	1·03, 1·53	1·37	1·12, 1·67	0·001
Heavy drinkers	1	Ref.	0·66	0·46, 0·95	0·91	0·64, 1·28	0·70	0·48, 1·01	0·186
Physical activity									
No									
Yes	1	Ref.	0·94	0·80, 1·12	0·91	0·77, 1·08	0·84	0·71, 0·99	0·038
Dietary supplement use									
No									
Yes	1	Ref.	1·26	1·07, 1·47	1·34	1·14, 1·57	1·16	0·98, 1·36	0·057

Ref., reference category.
*Adjusted for age.
†Non-drinkers (0 g/d); light drinkers (<12 g/d); and heavy drinkers (≥12 g/d).

higher adherence to the Mediterranean (healthy) dietary pattern were less likely to increase their alcohol consumption (OR = 0·66, 95 % CI 0·46, 0·95)[16]. In contrast, the Multiethnic Cohort Study in Hawaii found that the fat and meat dietary pattern was positively associated with BMI, smoking and alcohol consumption (≥1 drink/week; OR = 1·40, 95 % CI 1·37, 1·43)[14].

For physical activity and dietary supplement use, our study found both of these factors to be positively associated with all dietary patterns in both genders, with the exception of physical activity, which was inversely associated with the traditional dietary pattern in women. The EPIC–Potsdam study found that physical activity level was positively associated with the 'fruit and vegetable' dietary pattern in men ($\beta = 0{\cdot}182$) and was negatively associated with the 'bread and sausage' pattern in women ($\beta = 0{\cdot}099$)[10]. The Multiethnic Cohort Study found that physical activity (≥3 times/week) was positively associated with the vegetable (OR = 1·73, 95 % CI 1·69, 1·77) and fruit and milk patterns (OR = 1·44, 95 % CI 1·40, 1·47), but not with the fat and meat pattern (OR = 0·98, 95 % CI 0·96, 1·01)[14]. In addition, participants with the healthy pattern have been reported to have higher physical activity levels and to be more likely to take dietary

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supplements daily[27]. Likewise, in our study, physical activity was more strongly associated with the healthy dietary pattern than other dietary patterns in men (OR = 2·16, 95% CI 1·86, 2·53) and women (OR = 2·03, 95% CI 1·70, 2·41). Among 64 252 women in the French E3N-EPIC cohort, supplement use was positively associated with the fruit/vegetable pattern and inversely associated with the processed meat/starchy foods and alcohol/meat products patterns (*P* for trend for all associations <0·001)[33]. In the German Nutrition Survey, comprising 7124 men and women, significant differences in food consumption between regular vitamin and mineral supplement users and non-users were observed, indicating a tendency towards a healthier diet among regular users of supplements[19]. In a study by McNaughton *et al.*[11], dietary supplement use was positively associated with the fruit/vegetable pattern and inversely associated with a Western dietary pattern, and dietary supplement users tended to have a healthier lifestyle and diet than non-users.

Most dietary pattern studies have been conducted in North America or Europe, and only a few studies have been conducted in Asia and Korea. Thus, the results of the present study are important as they reflect dietary habits common in Asian countries. It is important to note that our study participants were volunteers recruited at one cancer screening centre; therefore, the results may not be generalizable to other Korean populations. However, the relatively high socio-economic status of our study population may contribute to more accurate responses regarding risk factors and may have helped to reduce errors related to internal validity. Yet the present study has a limitation. The FFQ focused on eating habits rather than actual food intake amounts. The FFQ did not ask about portion size, and therefore information on nutrient intake was not available. In addition, the use of an FFQ containing only sixteen food groups may restrict the number of food categories used to characterize the usual dietary intake. It is not clear to what degree this FFQ represents habitual food intake.

In summary, the present study found three different dietary patterns in a middle-aged Korean population and indicates that these dietary patterns are strongly associated with health behaviours. The healthy dietary patterns were mainly associated with other healthy lifestyle behaviour factors, including not smoking, low alcohol consumption, participating in physical activity and dietary supplement use. The possible confounding effect of other risk behaviours should be appropriately considered when conducting nutritional epidemiological studies of the association between dietary patterns and disease outcomes.

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Appendix

Food list for the sixteen food groups in the FFQ of the present study

Food group	Food list
Fast foods	Pizza, chicken, processed food
Animal fat-rich foods	High-fat red meat (beef, pork), processed food (ham, sausage), butter
Fried foods	Deep-fried food, stir-fried food
Grilled meat and seafood	Grilled ribs, barbecue, grilled squid
Sweet foods	Bread, cookies, chocolate, honey, candy, ice cream
Cholesterol-rich foods	Egg yolks, seafood (eel, shrimp, squid), organ meats (from fish or other animals)
Caffeinated drinks	Coffee, black tea, cocoa, coke
Green-yellow vegetables	Carrots, spinach, sesame leaf, lettuce, courgette, dropwort
Healthy protein foods	Lean meat, fish, *tofu*, legumes, egg whites
Seaweeds	Laver, brown seaweed, tangle
Bonefish	Anchovies, dried whitebait
Fruit	Apples, tangerines, grapes, watermelon, strawberries, peaches, pears, fruit juice
Dairy products	Yoghurt, cheese, milk
Salted vegetables and seafood	*Kimchi*, salted fermented seafood, food boiled in soya with spices
Cereals	Rice, bread, noodles, potatoes, sweet potatoes
Light-coloured vegetables	Bean sprouts, cucumbers, radishes, onions, bellflower