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Dietary inflammatory index is positively associated with serum high-sensitivity C-reactive protein in a Korean adult population



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ABSTRACT

Objective: To our knowledge, only a few studies have explored the relationship between the inflammatory potential of diet and serum inflammatory markers in Korean adults. The likely novel aim of this study was to examine the association between the dietary inflammatory index (DII) and serum high-sensitivity C-reactive protein (hs-CRP) in a Korean adult population.

Methods: A cross-sectional study was conducted using the data set from the Korea National Health and Nutrition Examination Survey (KNHANES) 2015. Korean adults ≥ 19 y of age with hs-CRP values were included in this study. After excluding individuals with missing variables for covariates, the final analytic sample for the study was 3014 adults (1295 men and 1719 women). DII scores were calculated from a 1-d 24-h dietary recall, and hs-CRP was measured using the immunoturbidimetric method. Multivariable logistic regression analyses were performed to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs) to test the effect of the DII score on serum hs-CRP as dichotomous (>2 versus ≤ 2 mg/L).

Results: A significant association was observed between increasing DII scores and elevated hs-CRP. Korean adults in the highest quintile of the DII (indicating the most proinflammatory diet), compared with the lowest quintile of the DII (indicating the most anti-inflammatory diet), had increased odds of having elevated hs-CRP concentrations (>2 mg/L; AOR, 1.70; 95% CI, 1.07–2.69; $P_{\text{trend}} < 0.0001$) after controlling for age, sex, education, marital status, alcohol consumption, smoking status, body mass index, high-density lipoprotein cholesterol, and physical activity.

Conclusion: Higher DII scores were positively associated with elevated hs-CRP levels in Korean adults. Because inflammation affects the risk for cancer, cardiovascular disease, and other inflammation-related conditions, future studies are warranted to examine the effect of the DII on other inflammatory biomarkers and chronic disease outcomes among the Korean population.

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JRH owns controlling interest in Connecting Health Innovations LLC (CHI), a company planning to license the right to his invention of the dietary inflammatory index (DII) from the University of South Carolina in order to develop computer and smart phone applications for patient counseling and dietary intervention in clinical settings. NS is an employee of CHI.

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Introduction

Chronic inflammation has been associated with a number of adverse health outcomes such as neurologic disorders [1,2], diabetic complications [3–5], cancer [6–8], and cardiovascular diseases (CVDs) [9]. Risk factors such as infection, cigarette smoking, and obesity influence inflammation; diet also plays a major role in the regulation of chronic inflammation [10]. Because diet is closely linked to inflammation, high consumption of fruits and vegetables [11,12], dietary fiber

[13–15], and ω -3 polyunsaturated fatty acids (PUFAs) [16] have been shown to reduce levels of inflammatory biomarkers such as C-reactive protein (CRP). By contrast, it has been shown that dietary fatty acids [17] and sugar [18] are associated with increased levels of CRP. In a population-based study of middle-aged Koreans, the “vegetable” dietary pattern, characterized by a high consumption of vegetables, was inversely associated with CRP levels [19]. A recent analysis of the Korea National Health and Nutrition Examination Survey (KNHANES) found a trend toward increased consumption of more Western fast food and sugar-sweetened beverages [20], both known to be dietary factors that increase levels of inflammation [21–23], in Korea. Although it is clear that there are recent dietary changes that may result in inflammation-related diseases, there is, to our knowledge, no comprehensive study investigating the inflammatory effects of the overall diet among the Korean population.

The dietary inflammatory index (DII) is a literature-derived, population-based dietary scoring system that quantifies the overall inflammatory potential of diet [24] and places an individual on a continuum from an extreme anti-inflammatory diet to an extreme proinflammatory diet. The DII is based on an extensive literature search incorporating cell culture, laboratory animal, and epidemiologic studies examining the effects of diet on inflammation. Previously, the DII was found to be associated with single markers of inflammation, specifically levels of CRP, interleukin (IL)-6, and tumor necrosis factor (TNF)- α [10,25–33]. Most of these studies were conducted in the United States or other European countries.

It has been found that in the Korean population, the DII is associated with health outcomes including cognitive decline and cancer [34,35]. However, data are limited with respect to validating the DII in a representative sample of the Korean population. To address gaps in the literature, the aim of the present study was to validate the DII in relation to the commonly studied inflammatory biomarker, high-sensitivity (hs)-CRP, which is an acute-phase protein [36], using a representative sample of Korean adults. We hypothesized that higher DII scores would be associated with elevated hs-CRP. We further hypothesized that the relationship between DII scores and hs-CRP could be modified by several risk factors such as age, weight status, smoking status, alcohol consumption, and level of physical activity.

Methods

Study population

A cross-sectional study was conducted using the KNHANES 2015 data set. In all, 7380 participants were available from the study. Participants <19 y of age ($n = 1435$) and those with cardiovascular diseases, such as stroke, myocardial infarction, and angina pectoris, and diabetes were excluded ($n = 1950$). Those with hs-CRP >10 mg/L or missing data for this variable ($n = 301$), with energy intake <500 or >5000 kcal ($n = 508$), and with incomplete information on sociodemographic variables ($n = 172$) also were excluded. The final analytic sample for the present study was 3014 Korean adults (1295 men and 1719 women).

Exposure variable

Dietary inflammatory index

The DII was developed by researchers at the University of South Carolina. Development and validation of the DII has been published previously [10,24]. In brief, the literature (~2000 articles) published between 1950 and 2010 was reviewed in terms of the relationship between various micronutrients, macronutrients, and whole food items (termed *food parameters*) and inflammation for the purposes of deriving inflammatory effect scores of the food parameters. At the same time, DII scores were standardized to a world database, which contains the means and standard deviations of intake of food parameters from 11 populations around the world [24]. For this study, the KNHANES dietary data, based on one 24-h dietary recall (24HR), were used to calculate the DII. The original DII includes 45 food parameters; however, only 23 the parameters were available and used for the calculation of the DII in this study. The following 23 DII food parameters were included: energy; carbohydrates; protein; fat; vitamins A, B₁, B₂, B₃ (niacin), and C;

iron; saturated fatty acids (SFAs); monounsaturated fatty acids (MUFAs); PUFAs; ω -3 and ω -6 PUFAs; dietary fiber; cholesterol; β -carotene; garlic; ginger; onion; pepper; and tea. Energy-adjusted values were obtained using the residual method. The world mean value for that food parameter was subtracted from the actual intake value for each food parameter and then divided by the world standard deviation to create a z-score. The next step converted the z-scores to proportions (with values from 0 to 1), which were then centered on 0 by doubling the value and subtracting 1 (i.e., from -1 to $+1$). This value was then multiplied by the inflammatory effect score for each food parameter. These were then summarized across all food parameters to derive the overall DII score. More positive scores indicate more proinflammatory diets; negative scores indicate more anti-inflammatory diets [24]. For this study, DII scores were calculated per 1000 calories consumed.

Outcome variable

Measurement of hs-CRP

In the 2015 KNHANES, blood samples were collected in 3 mL EDTA-coated tubes (BD Vacutainer, Franklin Lakes, NJ, USA). The immunoturbidimetric method was used for quantifying serum concentration of hs-CRP (Cobas, Roche, Germany), which is calibrated daily with reference standards between 1 and 200 mg/L [37].

Covariates

Data were collected on age (continuous), sex (men, women), years of education (≤ 6 , 7–12, ≥ 13 y), marital status (never married, married, separated/divorced/widowed), alcohol consumption (none, 1–4 times/mo, 2– ≥ 4 times/wk), smoking status (non-smoker or former smoker, current smoker), body mass index (BMI; continuous), high density lipoprotein cholesterol (HDL-C; continuous), and physical activity (yes, no).

Statistical analyses

Descriptive statistics of sociodemographic factors; lifestyle factors such as alcohol consumption, smoking status, and physical activity; BMI; hs-CRP; HDL-C; DII; and energy intake were computed overall and stratified by sex. χ^2 tests were used to examine differences in categorical variables between men and women and *t* tests were used to examine significant differences in continuous variables between men and women. Multivariable logistic regression analyses were used to calculate odds ratios (ORs) and 95% confidence intervals (CIs) for the association between the quintiles of DII and elevated hs-CRP dichotomized at >2 mg/L (considered as elevated [38]) or ≤ 2 mg/L after controlling for covariates. A linear test for trends across quintiles were estimated by modeling the median value of each category as a continuous variable. The sample weights of the participants were constructed to represent the Korean population by accounting for the complex survey design, survey non-response, and poststratification. All statistical analyses were conducted by using SAS version 9.4 (SAS Institute, Cary, NC, USA) and R Statistical Software (Foundation for Statistical Computing, Vienna, Austria).

Results

Sociodemographic characteristics and lifestyle factors are presented by sex in Table 1. Education level, marital status, alcohol consumption, smoking status, physical activity levels, BMI, HDL-C, DII, and energy intake significantly differed by sex (all $P < 0.05$). Men were more likely to have a higher education level than women (61.5% versus 51.7% with some postsecondary school education), and they were more likely to be single (30.9% versus 22.4%). Men were more likely than women to drink 2 to ≥ 4 times/wk (33.3% versus 11.8%). Men also were more likely than women to be smokers (36.2% versus 4.6%). A higher percentage of women than men reported regular physical activity (48.1% versus 42.6%). Men had significantly higher BMI, DII score, and energy intake and lower HDL-C and estimated glomerular filtration rate (eGFR) than women (all $P < 0.0001$).

Sociodemographic characteristics and lifestyle factors across the quintiles of DII are presented in Table 2. Sex, education, marital status, alcohol consumption status, smoking status, age, energy intake, and eGFR significantly differed by the quintiles of the DII (all $P < 0.05$). Study participants in the highest quintile (most proinflammatory diet; DII ranges 1.265–3.867) were more likely to be men, have an education level ≥ 13 y, be married, and drink 1 to 4 times/mo. They also were more likely younger and reported

Table 1
Sociodemographic characteristics and biomarkers of study participants by sex

	Men (n = 1295)		Women (n = 1719)		P-value*
	n	Weighted %	n	Weighted %	
Education (y)					
≤6	138	6.5	254	10.1	<0.0001
7–12	478	32.0	695	38.2	
≥13	679	61.5	770	51.7	
Marital status					
Never married	300	30.9	279	22.4	<0.0001
Married	919	64.6	1,183	66.8	
Separated/Divorced/Widowed	76	4.4	257	10.8	
Household income					
Lowest	160	10.0	223	10.2	0.88
Lower middle	311	22.0	399	21.8	
Upper middle	384	32.1	519	32.1	
Highest	440	36.0	578	35.9	
Alcohol consumption					
None	313	22.6	867	47.7	<0.0001
1–4 × /mo	525	44.1	659	40.5	
2 to ≥4 × /wk	457	33.3	193	11.8	
Smoking status					
Non- or former smoker	865	63.8	1,646	95.4	<0.0001
Current smoker	430	36.2	73	4.6	
Physically active					
Yes	600	42.6	900	48.1	0.01
No	695	57.4	819	51.9	
	Mean	SEM	Mean	SEM	P-value
Age (y)	43.0	0.5	43.1	0.4	0.56
BMI (kg/m ²)	24.4	0.1	22.9	0.1	<0.0001
hs-CRP (mg/L)	0.96	0.04	0.93	0.04	0.25
HDL cholesterol (mg/dL)	48.0	0.3	56.8	0.4	<0.0001
DII	0.07	0.04	−0.24	0.04	<0.0001
Total energy intake (kcal/d)	2466	29	1842	19	<0.0001
eGFR (mL/min/1.73 m ²)	93.6	0.6	99.2	0.7	<0.0001

BMI, body mass index; DII, dietary inflammatory index; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein; hs-CRP: high-sensitivity C-reactive protein; SEM, standard error of the mean.

*P-value based on χ^2 test for categorical variables and *t* test for continuous variables.

[†]eGFR was calculated using the following formula: $186.3 \times (\text{serum creatinine})^{-1.154} \times \text{age}^{-0.203} \times (0.742 \text{ for women})$ [47].

higher energy intake. Study participants in the lowest quintile (most anti-inflammatory diet; DII ranges −4.236 to −1.127) were more likely to be women and to be never or former smokers (all *P* < 0.05).

Correlation analyses for DII, age, BMI, HDL-C levels, low-density lipoprotein cholesterol (LDL-C) levels, hs-CRP, energy, and other nutrients are shown in Figure 1. DII was significantly and positively associated with intake of total energy, total fat, SFAs, MUFAs, and retinol (all *P* < 0.05). DII scores were significantly and negatively associated with age, LDL-C concentrations, moisture, protein, PUFAs, ω -3 and ω -6 fatty acids, dietary fiber, calcium, phosphorus, iron, sodium, potassium, vitamin A, β -carotene, vitamin B₁, vitamin B₂, niacin, and vitamin C (all *P* < 0.05; Fig. 1).

Korean adults in the highest quintile (Q5, most proinflammatory diet) had marginally increased risk for having elevated hs-CRP concentrations (>2 mg/L) compared with those Korean adults in the lowest quintile (Q1, most anti-inflammatory diet; OR, 1.53; 95% CI, 0.99–2.37; *P*_{trend} < 0.0001) in an unadjusted model. In a fully adjusted model, Korean adults in the highest quintile had increased odds of having elevated hs-CRP (adjusted OR [AOR], 1.70; 95% CI, 1.07–2.69; *P*_{trend} < 0.0001; Table 3).

The association between DII scores and hs-CRP levels was further stratified by lifestyle factors such as weight status, age, smoking status, alcohol consumption, and physical activity. Korean adults who were former or never smokers and in the highest DII quintile had increased odds of having elevated hs-CRP levels (AOR, 2.01; 95% CI, 1.23–3.28; *P*_{trend} < 0.0001).

Korean adults who were non-drinkers and in the highest DII quintile had increased odds of having elevated hs-CRP levels (AOR, 2.30; 95% CI, 1.20–4.37; *P*_{trend} < 0.0001). Those adults who did not report any physical activity and who had the most proinflammatory diet had increased odds of having elevated hs-CRP concentrations (AOR, 1.82; 95% CI, 1.04–3.19; *P*_{trend} < 0.0001; Table 4).

Discussion

In the present study, higher DII scores were positively associated with elevated hs-CRP levels, suggesting that the DII can be used as a valid tool to assess the inflammatory potential of diet in Korean adults. A proinflammatory diet, as indicated by a higher DII score, is associated with increased odds of elevated hs-CRP levels (>2 mg/L). A significant and positive association between DII scores and hs-CRP concentrations in Korean adults persisted after controlling for multiple confounding variables such as age, sex, education, marital status, alcohol consumption, smoking, BMI, HDL-C, and physical activity.

Consistent with our findings, in the longitudinal SEASONS (Seasonal Variation of Blood Cholesterol Study) [10], the DII from both three 24HRs and a 7-d dietary recall (7DDR), each taken at five points over a year (i.e., ≤15 24HRs and 5 7DDRs), was able to predict odds of having an elevated hs-CRP levels in the US population. The study found that higher DII scores were associated with increased odds of elevated hs-CRP >3 mg/L (OR, 1.08; 95% CI,

Table 2
Sociodemographic characteristics and biomarkers of study participants across the quintiles of DII

	Quintile (Q) of energy-adjusted DII										P-value ¹
	Q1 (n = 602)		Q2 (n = 603)		Q3 (n = 603)		Q4 (n = 603)		Q5 (n = 603)		
	n	Weighted %	n	Weighted %	n	Weighted %	n	Weighted %	n	Weighted %	
Sex											
Men	217	42.6	239	48.5	240	46.9	280	54.5	319	59.7	<0.0001
Women	385	57.4	364	51.5	363	53.1	323	45.5	284	40.3	
Education (y)											0.0002
≤6	60	7.4	75	8.2	79	7.9	99	10.7	79	7.2	
7–12	284	42.4	247	35.9	238	37.8	207	30.5	197	30.1	
≥13	258	50.3	281	55.9	286	54.3	297	58.8	327	62.7	
Marital status											<0.0001
Never married	57	13.6	91	22.2	112	26.5	127	28.4	192	39.6	
Married	479	77.7	432	68.4	431	67.0	406	63.6	354	54.6	
Separated/Divorced/Widowed	66	8.7	80	9.4	60	6.5	70	8.0	57	5.7	
Household income											0.2942
Lowest	70	9.4	78	10.8	82	9.9	66	7.8	87	12.3	
Lower middle	131	19.6	149	21.9	130	19.6	162	25.9	138	22.4	
Upper middle	188	34.8	166	30.3	185	33.6	171	29.7	193	32.1	
Highest	213	36.3	210	37.1	206	36.9	204	36.5	185	33.2	
Alcohol consumption											<0.0001
None	263	40.3	254	37.1	266	40.6	228	33.2	169	25.3	
1–4 × /mo	233	40.9	243	45.0	212	38.1	235	42.4	261	45.0	
2 to ≥4 × /wk	106	18.8	106	17.8	125	21.3	140	24.4	173	29.7	
Smoking status											<0.0001
Non- or former smoker	547	88.6	520	82.0	507	81.8	491	76.9	446	69.6	
Current smoker	55	11.4	83	18.0	96	18.2	112	23.1	157	30.4	
Physically active											0.4927
No	289	43.9	297	45.5	324	48.8	296	45.1	294	43.4	
Yes	313	56.1	306	54.5	279	51.2	307	54.9	309	56.6	
	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	Mean	SEM	P-value
Age (y)	47.8	0.7	45.3	0.7	43.2	0.7	42.1	0.7	38.1	0.7	<0.0001
BMI (kg/m ²)	24.0	0.2	23.7	0.2	23.6	0.2	23.5	0.2	23.7	0.2	0.1973
HDL cholesterol (mg/dL)	52.4	0.7	52.4	0.6	51.7	0.6	51.7	0.5	53.2	0.6	0.5411
Total energy intake (kcal/d)	1998	39	2120	46	2103	39	2217	48	2319	41	<0.0001
eGFR (mL/min/1.73 m ²) [‡]	95.2	0.9	95.3	0.9	96.3	0.9	96.5	0.9	98.0	0.8	0.0088

BMI, body mass index; DII, dietary inflammatory index; eGFR, estimated glomerular filtration rate; HDL, high-density lipoprotein.

^{*}DII ranges for Q1, Q2, Q3, Q4, and Q5 are as follows: −4.236 to −1.127; −1.125 to −0.230; −0.229 to 0.466; 0.466 to 1.264; and 1.265 to 3.867, respectively.

¹P-value based on χ^2 test for categorical variables and analysis of variance for continuous variables.

[‡]eGFR was calculated using the following formula: $186.3 \times (\text{serum creatinine})^{-1.154} \times \text{age}^{-0.203} \times (0.742 \text{ for women})$ [47].

1.01–1.16 for the 24HR data; and OR, 1.10; 95% CI, 1.02–1.19 for the 7DDR data). Similarly, in the US National Health and Nutrition Examination Survey (NHANES), DII as a continuous variable was associated with CRP ≥ 3 mg/L (OR, 1.12; 95% CI, 1.05–1.19) [39].

In our stratified analyses, we found that the associations between DII and an elevated hs-CRP was modified by smoking status and physical activity, respectively. Korean adults adhering to a proinflammatory diet who were former or never smokers and non-drinkers and who did not participate in physical activity were more likely to have elevated hs-CRP. In an Italian case-control study [40], researchers examined the association between the DII and the risk for pancreatic cancer, along with factors such smoking status. When stratified by smoking status, a significant positive association between increasing DII scores and the risk for pancreatic cancer was found among never smokers (OR, 2.32; 95% CI, 1.08–4.99) and former smokers (OR, 3.37; 95% CI, 1.22–9.35).

When the DII was treated as a continuous variable in this study, no significant association was observed. This is, in part, due to the non-linear relationship between DII and hs-CRP [27]. Also, hs-CRP was not linearly distributed; so, it is not reasonable to fit a linear regression model and expect accurate results. Our results for the continuous DII are in agreement with other studies examining the relationship between continuous DII scores and CRP levels [26,29]. In the Asklepios study, a longitudinal population-based study in

Belgium [29], the proinflammatory diet was positively associated with IL-6 and homocysteine, but was not associated with CRP and fibrinogen. The authors explained that 17 food parameters used in this study to calculate the DII (rather than the 45 in the original calculation of the DII) could partially explain the absence of a significant association between DII and CRP. This may be applicable to our study results given that the DII, as a continuous variable, was not significantly associated with hs-CRP levels, and 23 food parameters were used to calculate the DII. Therefore, future investigation is required to associate DII (calculated with as many food parameters as possible) with various serum inflammatory markers including hs-CRP. We found that young Korean adults had a more proinflammatory diet, indicated by higher DII scores, as well as higher LDL-C levels. There was a very weakly negative relationship between DII score and LDL-C in these cross-sectional data ($r = -0.04$; $P_{\text{partial}} = 0.02$). This is not surprising given that it has been known for a long time (nearly 40 y) that cross-sectional values in dietary factors known to affect LDL-C longitudinally are unrelated to LDL-C cross-sectionally [41].

In previous findings, a proinflammatory diet indicated by higher DII scores has been closely linked to adverse health outcomes or factors such as colorectal cancer [42], prostate cancer [43], pancreatic cancer [40], lung function [25], general obesity [44], and high prepregnancy BMI [45] in various global populations. The present

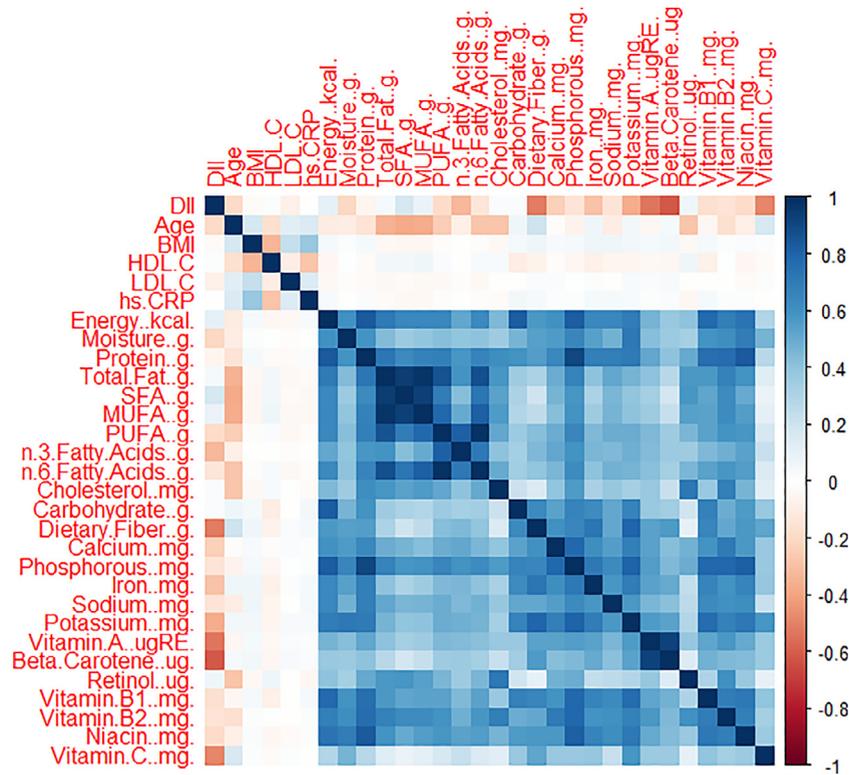


Fig. 1. Correlation coefficients for DII, age, BMI, biomarkers, energy, and nutrients. Blue shades denote the positive correlation coefficients, whereas red shades denote the negative correlation coefficients. BMI, body mass index; DII, dietary inflammatory index; HDL-C, high-density lipoprotein cholesterol; hs-CRP, high-sensitivity C-reactive protein; LDL-C, low-density lipoprotein cholesterol; MUFA, monounsaturated fatty acid; PUFA, polyunsaturated fatty acid; SFA, saturated fatty acid.

Table 3
Unadjusted and adjusted* ORs for association between DII and elevated hs-CRP (>2 mg/L)

	Quintile (Q) of energy-adjusted DII [†]					P _{trend}
	Q1 (n = 602)	Q2 (n = 603)	Q3 (n = 603)	Q4 (n = 603)	Q5 (n = 603)	
Unadjusted model	1.00 (Ref.)	1.05 (0.68–1.63)	1.17 (0.75–1.82)	1.22 (0.80–1.85)	1.53 (0.99–2.37)	<0.0001
Adjusted model	1.00 (Ref.)	1.14 (0.73–1.79)	1.17 (0.74–1.84)	1.31 (0.84–2.05)	1.70 (1.07–2.69)	<0.0001

DII, dietary inflammatory index; hs-CRP, high-sensitivity C-reactive protein.

*Adjusted for age, sex, education, marital status, alcohol consumption, smoking status, body mass index, high-density lipoprotein cholesterol, and physical activity.

[†]DII ranges for Q1, Q2, Q3, Q4, and Q5 are as follows: -4.236 to -1.127; -1.125 to -0.230; -0.229 to 0.466; 0.466 to 1.264; and 1.265 to 3.867, respectively. A linear test for trend was conducted using the median approach.

study provided additional evidence on the applicability of DII to assess the inflammatory potential of dietary intakes in Korean adults. These findings could be extended to future studies to examine the validated DII with other inflammation-related health outcomes among Koreans.

There are several strengths that pertained to this study. First, it was a large representative sample of Korean adults. Second, using hs-CRP instead of CRP enabled the measurement of the level of chronic inflammation. Finally, a number of confounding variables such as physical activity, smoking status, and alcohol consumption could be controlled in the study. Despite its strengths, the study was not without limitations. First, one 24HR may not represent the usual dietary intake of an individual owing to day-to-day variation and other sources of intraperson variability [46]. Despite this, increasing DII scores derived from one 24HR have been shown to be associated with increased CRP in the US NHANES [31, 39]. Although only 23 food parameters, compared with 45 in the

original DII calculation, were used to calculate DII scores, DII as a categorical variable was associated with an elevated hs-CRP level. Finally, because of the cross-sectional study design of the KNHANES, the temporal component of the cause–effect relationship for the DII versus hs-CRP cannot be established.

Conclusion

Higher DII scores are positively associated with elevated hs-CRP levels in Korean adults. These findings support one of the mechanisms relevant to the pathway between diet and inflammation-related diseases. In the future, longitudinal studies are warranted to better understand the relationship among the DII, inflammatory markers, and various chronic disease outcomes in the Korean population.

Table 4
Adjusted* ORs for association between dietary inflammatory index (DII) and elevated high-sensitivity C-reactive protein (>2 mg/L) by the stratification of risk factors

	Quintile (Q) of energy-adjusted DII [†]					P _{trend}
	Q1 (n = 602)	Q2 (n = 603)	Q3 (n = 603)	Q4 (n = 603)	Q5 (n = 603)	
BMI (kg/m ²)						
<23 (n = 1348)	1.00 (Ref.)	0.99 (0.44–2.22)	0.83 (0.35–1.98)	1.84 (0.85–3.99)	1.87 (0.91–3.85)	<0.0001
≥23 (n = 1666)	1.00 (Ref.)	1.15 (0.67–1.97)	1.30 (0.79–2.13)	1.06 (0.62–1.82)	1.54 (0.90–2.64)	<0.0001
Age (y)						
<50 (n = 1617)	1.00 (Ref.)	1.15 (0.56–2.34)	1.35 (0.67–2.72)	1.29 (0.64–2.59)	1.74 (0.88–3.44)	<0.0001
≥50 (n = 1397)	1.00 (Ref.)	1.07 (0.61–1.89)	0.87 (0.45–1.67)	1.35 (0.70–2.63)	1.69 (0.93–3.10)	<0.0001
Smoking status						
Non- or former smoker (n = 2511)	1.00 (Ref.)	1.52 (0.88–2.62)	1.12 (0.63–2.01)	1.80 (1.12–2.89)	2.01 (1.23–3.28)	<0.0001
Current smoker (n = 503)	1.00 (Ref.)	0.34 (0.09–1.21)	0.95 (0.30–3.02)	0.38 (0.11–1.25)	0.71 (0.24–2.13)	<0.0001
Alcohol consumption						
None (n = 1180)	1.00 (Ref.)	1.10 (0.54–2.28)	0.92 (0.46–1.83)	1.52 (0.78–2.96)	2.30 (1.20–4.37)	<0.0001
1–4/mo (n = 1184)	1.00 (Ref.)	1.35 (0.60–3.03)	1.73 (0.82–3.61)	1.39 (0.62–3.14)	1.70 (0.83–3.46)	<0.0001
2 to ≥4/wk (n = 650)	1.00 (Ref.)	1.07 (0.42–2.73)	1.11 (0.35–3.52)	1.16 (0.42–3.20)	1.19 (0.41–3.43)	<0.0001
Physically active						
No (n = 1500)	1.00 (Ref.)	1.34 (0.79–2.25)	1.07 (0.58–1.96)	1.07 (0.56–2.08)	1.82 (1.04–3.19)	<0.0001
Yes (n = 1514)	1.00 (Ref.)	0.92 (0.46–1.85)	1.21 (0.63–2.34)	1.50 (0.80–2.82)	1.36 (0.63–2.94)	<0.0001

DII, dietary inflammatory index; hs-CRP, high-sensitivity C-reactive protein.

*Adjusted for age, sex, education, marital status, alcohol consumption, smoking status, body mass index, high-density lipoprotein cholesterol, and physical activity.

[†]DII ranges for Q1, Q2, Q3, Q4, and Q5 are as follows: −4.236 to −1.127; −1.125 to −0.230; −0.229 to 0.466; 0.466 to 1.264; and 1.265 to 3.867, respectively. A linear test for trend was conducted using the median approach.

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