NUTRITION RESEARCH 36 (2016) 214–219

Available online at www.sciencedirect.com

ScienceDirect

www.nrjournal.com

Communication

Anti-inflammatory Dietary Inflammatory Index scores are associated with healthier scores on other dietary indices

Michael D. Wirth[a,b,c,*], James R. Hébert[a,b,c], Nitin Shivappa[a,b,c], Gregory A. Hand[d], Thomas G. Hurley[a], Clemens Drenowatz[e], Daria McMahon[a,b], Robin P. Shook[f], Steven N. Blair[b,e]

[a] South Carolina Statewide Cancer Prevention and Control Program, University of South Carolina, 915 Greene St, Suite 200, Columbia, SC 29208, USA
[b] Department of Epidemiology and Biostatistics, University of South Carolina, 915 Greene St, Suite 200, Columbia, SC 29208, USA
[c] Connecting Health Innovations LLC, 1417 Gregg St, Columbia, SC 29201, USA
[d] Department of Epidemiology, West Virginia University, One Medical Drive Center, PO Box 9190, Morgantown, WV 26506, USA
[e] Department of Exercise Science, University of South Carolina, 921 Assembly St, Columbia, SC 29208, USA
[f] Department of Kinesiology, Iowa State University, 241 Forker Bldg, Ames, IA 5001, USA

ARTICLE INFO

Article history:
Received 3 August 2015
Revised 10 November 2015
Accepted 13 November 2015

Keywords:
Dietary Inflammatory Index
Observational
Inflammation
Diet
Chronic disease

ABSTRACT

Dietary components are important determinants of systemic inflammation, a risk factor for most chronic diseases. The Dietary Inflammatory Index (DII) was developed to assess dietary inflammatory potential. It was hypothesized that anti-inflammatory DII scores would be associated with "healthier" scores on other dietary indices. The Energy Balance Study is an observational study focusing on energy intake and expenditure in young adults; only baseline data were used for this analysis (n = 430). The DII, as well as the Healthy Eating Index-2010 (HEI-2010), the Alternative Healthy Eating Index (AHEI), and the Dietary Approaches to Stop Hypertension Index (DASH) were calculated based on one to three 24-hour dietary recalls. General linear models were used to estimate least square means of the AHEI, HEI-2010, and DASH according to DII quartiles. Those with higher (ie, more proinflammatory) DII scores were more likely to be males, have less than a completed college education, and be younger. In addition, those with higher scores for cognitive restraint for eating or drive for thinness had lower (ie, anti-inflammatory) DII scores. Linear regression analyses indicated that as the DII increased, the AHEI, HEI-2010, and DASH dietary indices decreased (ie, became more unhealthy, all $P < .01$). The DII is a novel tool that characterizes the inflammatory potential of diet and is grounded in the peer-reviewed literature on diet and inflammation. Findings from the Energy Balance Study indicate that the DII is associated with other dietary indices, but has the added advantage of specifically measuring dietary inflammatory potential, a risk factor for chronic disease.

Abbreviations: AHEI, Alternative Healthy Eating Index; BMI, body mass index; DII, Dietary Inflammatory Index; DASH, Dietary Approaches to Stop Hypertension; EDI, Eating Disorder Inventory; HEI-2010, Healthy Eating Index-2010; IL, interleukin; TFEQ, Three-Factor Eating Questionnaire; WHR, waist-to-hip ratio.

* *Corresponding author at:* Cancer Prevention and Control Program, University of South Carolina, 915 Greene St, Room 233, Columbia, SC 29208, USA. Tel.: +1 803 576 5646; fax: +1 803 576 5624.
E-mail address: wirthm@mailbox.sc.edu (M.D. Wirth).

http://dx.doi.org/10.1016/j.nutres.2015.11.009
0271-5317/

1. Introduction

Diet is a strong moderator of chronic, systemic inflammation [1]. For example, "unhealthy" dietary patterns (eg, Western-style diets high in fats, refined carbohydrates, and protein) are typically associated with higher levels of inflammation, whereas "healthier" diets (eg, Mediterranean diets high in fruits, vegetables, and fish) are associated with lower levels of inflammation [1]. This is disconcerting considering that chronic inflammation, which can occur as a result of repeated injuries or stressors on the body, including poor diet, is associated with most major chronic disorders (eg, cardiovascular disease, cancer, and diabetes) [2,3].

Typically, dietary quality indices are based on a priori dietary guideline definitions (eg, Healthy Eating Index [HEI]) [3]. The Dietary Inflammatory Index (DII) is a relatively new dietary index that is based on peer-reviewed research focusing on diet and inflammation and is standardized to world average dietary intake [4]. The DII was validated against inflammatory biomarkers in previous research [5–7]. The DII also has been associated with other outcomes including, but not limited to, cancer, anthropometric measures, and asthma [8–10]. Based on the fact that healthier diets incorporate many foods that contain anti-inflammatory constituents, it is not surprising that more anti-inflammatory DII scores were observed with various types of vegetarian diets in a randomized control trial [11] or with healthier diets in a simulation analysis compared with a fast food diet [12].

However, to date, no DII analysis has examined the relationship between the DII and other established and commonly used dietary indices such as the HEI-2010, the Alternative Healthy Eating Index (AHEI), and the Dietary Approaches to Stop Hypertension (DASH) [13–15]. Therefore, this analysis addressed the hypothesis that more anti-inflammatory (ie, lower) DII scores would be associated with healthier (ie, higher) scores on the HEI-2010, AHEI, and DASH indices using data collected from the Energy Balance observational study (University of South Carolina, Columbia, SC, USA), including 24-hour recalls (24HRs) [16].

2. Methods and materials

2.1. Study design

The Energy Balance Study, which is a prospective cohort (follow-up visits occurred every 3 months), was designed to examine the impact of energy expenditure and intake on changes in body habitus in 430 young adults. Methodology for the Energy Balance Study has been described elsewhere [16]. In short, eligible participants were between 21 and 35 years of age, had a body mass index (BMI) of 20 to 35 kg/m^2, and lived in or near Columbia, South Carolina. Exclusions were applied at recruitment and included major acute or chronic health conditions, plans to move out of the study area within the first year of follow-up, or large changes in body composition prior to the study start date. Only baseline data were used for this cross-sectional analysis. The Energy Balance Study was approved by the institutional review board of the University of South Carolina, and all participants provided written informed consent.

2.2. Dietary data collection and indices

Dietary information was collected by telephone-administered 24HRs over a 14-day period. The Nutrient Data System for Research (version 2012; Nutrition Coordinating Center, University of Minnesota, Minneapolis, MN, USA) was used to estimate average energy, nutrient, and individual food intakes from the 24HR. Dietary data from the 24HRs were used to calculate the HEI-2010, AHEI, DASH, and DII. The HEI-2010, AHEI, and DASH were created and scored in accordance with previous scoring guidelines [13–15].

The HEI-2010 was updated compared with the HEI-2005 based on recommendations in the 2010 Dietary Guidelines released by the USA Department of Agriculture. The HEI-2010 is made up of 9 adequacy components (total fruit, whole fruit, total vegetables, greens and beans, whole grains, dairy, total protein foods, seafood and plant proteins, and fatty acids) and 3 moderation components (refined grains, sodium, and empty calories). Each component has standards for maximum scores and scores of zero. Values falling between zero and the maximum are scored proportionally [14]. The AHEI is composed of 9 components including servings of vegetables, fruits, nuts and soy protein, and alcohol; ratio of white to red meat; cereal fiber grams; percent of energy from trans-fat; ratio of polyunsaturated to saturated fat; and duration of multivitamin use. All components are proportionally scored on a scale of 0 to 10 based on minimum and maximum criteria [15]. It should be noted that duration of multivitamin use was not available within Energy Balance; therefore, this component was based on a "yes/no" response with 7.5 points for yes and 2.5 points for no. DASH index scores were calculated based on quintiles (scored 1-5) of servings per day for fruits, vegetables, nuts and legumes, whole grains, low-fat dairy, sodium, red and processed meats, and sweetened beverages; values were summed across these 8 components with sodium, meats and sweetened beverages being scored in reverse order [13]. Higher HEI-2010 (range, 0-100), AHEI (range, 2.5-97.5), and DASH (range, 8-40) scores indicate healthier diets.

Inflammatory effect scores derived from data reported in 1943 research articles examining the relationship between various dietary constituents (referred to as food parameters) and inflammation (interleukin [IL]-1β, IL-4, IL-6, IL-10, tumor necrosis factor α, and C-reactive protein) became the basis for the DII. Exposure estimates were scored relative to a "world" database (based on 11 populations from around the world including the United States, the United Kingdom, Bahrain, Mexico, Australia, South Korea, Taiwan, India, New Zealand, Japan, and Denmark) which consists of means and standard deviations for DII food parameters. The DII food parameters used to calculate DII scores within the Energy Balance Study included the following: carbohydrates; protein; fat; alcohol and fiber; cholesterol; saturated, monounsaturated, and polyunsaturated fatty acids; omega-3 and omega-6 fatty acids; trans-fat; niacin; thiamin; riboflavin; vitamins A, B_6, B_{12}, C, D, and E; iron; magnesium; zinc; selenium; folate; β-carotene; anthocyanidins; flavan-3-ols; flavones; flavonols;

Table 1 – Population characteristics by DII quartiles

Characteristic	DII Quartile 1	DII Quartile 2	DII Quartile 3	DII Quartile 4	P
Sex					.01
Male	40 (38%)	50 (46%)	57 (53%)	63 (59%)	
Female	66 (62%)	58 (54%)	50 (47%)	43 (41%)	
Race					.13
European American	78 (74%)	75 (69%)	71 (66%)	60 (57%)	
African American	8 (8%)	9 (8%)	16 (15%)	21 (20%)	
Asian	11 (10%)	12 (11%)	8 (7%)	15 (14%)	
Other	9 (8%)	12 (11%)	12 (11%)	10 (9%)	
Income (in dollars)					.61
0-19999	18 (17%)	18 (17%)	16 (15%)	19 (18%)	
20000-39999	32 (30%)	34 (32%)	44 (41%)	38 (36%)	
40000-59999	21 (20%)	25 (23%)	20 (19%)	19 (18%)	
60000-79999	12 (11%)	10 (9%)	13 (12%)	18 (17%)	
80000+	22 (21%)	20 (19%)	14 (13%)	12 (11%)	
Education					<.01
<3 y ars of college	10 (9%)	19 (18%)	12 (11%)	29 (27%)	
4+ y of college	96 (91%)	89 (82%)	95 (89%)	77 (73%)	
Children					.03
Yes	12 (11%)	12 (12%)	14 (13%)	25 (24%)	
No	94 (89%)	96 (89%)	92 (87%)	81 (76%)	
Currently dieting					.07
Yes	24 (23%)	31 (29%)	21 (20%)	15 (14%)	
No	82 (77%)	77 (71%)	85 (80%)	91 (86%)	
Smoking status					.46
Current/Former	23 (22%)	28 (26%)	24 (22%)	32 (30%)	
Never	83 (78%)	80 (74%)	83 (78%)	74 (70%)	
Continuous Measures					
Age (y)	27.8 ± 3.7	27.4 ± 3.6	27.1 ± 3.7	26.5 ± 4.1	.01
Social Approval score	51.0 ± 8.4	51.5 ± 9.8	50.5 ± 9.4	52.9 ± 9.5	.26
Drive for thinness [a,b]	4.0 ± 4.6	3.3 ± 4.4	2.9 ± 4.0	3.0 ± 4.4	.07
Cognitive restraint [c]	12.4 ± 4.6	10.5 ± 4.5	9.8 ± 4.4	8.4 ± 5.2	<.01
Physical activity hours [d]	5.9 ± 1.5	5.9 ± 1.5	5.8 ± 1.5	5.9 ± 1.5	.86
Steps	7920 ± 3040	7536 ± 2173	7492 ± 2846	7700 ± 2839	.53
BMI (kg/m^2)	25.1 ± 3.8	25.4 ± 3.4	25.7 ± 3.8	25.4 ± 4.3	.58
Body fat percent	29.1 ± 8.8	28.4 ± 9.4	28.9 ± 9.4	27.6 ± 8.4	.27
WHR	0.78 ± 0.07	0.79 ± 0.07	0.79 ± 0.07	0.80 ± 0.07	.04

Column percentages not equaling 100% are due to rounding. Column totals not equaling total sample size are due to missing data. *P* values for categorical variables were based on χ^2 tests, and *P* values for continuous measures were based on trend test using general linear models. DII quartile ranges: 1 = −4.93 to −0.90 (n = 106); 2 = −0.89 to 1.02 (n = 108); 3 = 1.03 to 2.50 (n = 107); and 4 = 2.51 to 6.23 (n = 106).

[a] Subscale of the EDI = higher scores indicate a greater drive for thinness.

[b] Statistically significant difference ($P < .05$) between DII quartiles 1 and 4 using *t* tests.

[c] Subscale of the TFEQ = higher score indicates greater cognitive restraint.

[d] Average daily hours of all (ie, light to vigorous physical activity).

flavonones; isoflavones; caffeine; garlic; ginger; onions; saffron; turmeric; pepper; thyme or oregano; rosemary; and tea. World means were subtracted from the actual intake and divided by its standard deviation, creating a z score. These were converted to percentiles to control for skewing and were centered on 0 by doubling the percentiles and subtracting 1.0. These centered scores were then multiplied by the inflammatory effect scores and then summed across all food parameters. More details on DII calculation can be found elsewhere [4]. Higher scores are more proinflammatory and lower scores are anti-inflammatory (theoretically maximum range, −8.87 to 7.98). Dietary Inflammatory Index scores were calculated per 4184 KJ (1000 kilocalories) consumed to account for inter-individual differences in energy intakes.

2.3. *Covariate information*

Potential covariates for adjustment included BMI (BMI = weight (kg)/height (m)^2], percent body fat (from dual x-ray absorptiometry), waist-to-hip ratio (WHR), demographic, and health habit information (eg, age, sex, race, education, income, employment, marital status, smoking status). In addition, psychosocial measures (eg, social approval and desirability, Perceived Stress Scale [17], Eating Disorder Inventory [EDI] [18], Three-Factor Eating Questionnaire [TFEQ] [19]) were included. The EDI measures various behavioral and psychological traits associated with anorexia nervosa and bulimia [18]. The TFEQ measures 3 dimensions of eating behavior including cognitive restraint of eating, disinhibition, and hunger [19]. Physical activity (ie, total

Table 2 – HEI-2010, AHEI, and DASH by quartiles of the DII among all participants and stratified by sex

Dietary indices	All participants					
	DII Quartile 1	DII Quartile 2	DII Quartile 3	DII Quartile 4	*P*: 1 vs 4	*P*: cont
HEI-2010	66.2 (63.6-68.8)	59.6 (57.2-62.0)	55.3 (52.8-57.8)	48.2 (45.9-50.5)	<.01	<.01
AHEI	53.8 (51.2-56.5)	50.1 (47.7-52.5)	45.3 (42.8-47.8)	39.0 (36.7-41.3)	<.01	<.01
DASH	25.5 (24.4-26.6)	22.9 (21.8-23.9)	21.7 (20.6-22.7)	19.9 (18.9-20.9)	<.01	<.01
Male						
HEI-2010	64.2 (60.3-68.1)	60.3 (56.7-64.0)	54.9 (51.6-58.3)	47.0 (43.9-50.2)	<.01	<.01
AHEI	52.3 (48.4-56.2)	50.8 (47.1-54.4)	45.6 (42.3-49.0)	37.0 (33.8-40.2)	<.01	<.01
DASH	25.7 (24.0-27.4)	23.3 (21.8-24.9)	22.1 (20.7-23.5)	19.9 (18.6-21.3)	<.01	<.01
Female						
HEI-2010	67.5 (64.2-70.7)	58.8 (55.6-62.1)	55.7 (52.1-59.2)	49.7 (46.3-53.0)	<.01	<.01
AHEI	54.7 (51.5-57.9)	49.2 (46.0-52.5)	44.6 (41.0-48.2)	41.6 (38.3-44.9)	<.01	<.01
DASH	25.3 (23.9-26.6)	22.4 (21.1-23.8)	21.5 (19.6-22.7)	20.0 (18.6-21.5)	<.01	<.01

Least square means and 95% confidence intervals of the HEI-2010, AHEI, and DASH are presented per DII quartile using generalized linear models. DII quartile ranges: 1 = −4.93 to −0.90 (n = 106); 2 = −0.89 to 1.02 (n = 108); 3 = 1.03 to 2.50 (n = 107); and 4 = 2.51 to 6.23 (n = 106). Higher scores on the HEI-2010, AHEI, and DASH are more favorable and indicate a "healthier" diet. Adjustments: all models adjusted for education, employment, number of children, current dieting status, race, age, social approval, thinness subscale from the EDI, cognitive restraint subscale of the TFEQ, BMI (kg/m^2), percent body fat, and WHR.
P: 1 vs 4 represents the *P* value for the difference between DII quartiles 4 and 1 determined by generalized linear models. *P*: cont represents the *P* value for the linear relationship between the DII and each index determined by generalized linear models.

light, moderate, and vigorous physical activity, as well as steps) and sleep estimates were obtained through BodyMedia's SenseWear Mini physical activity monitor [16]. On average, participants wore the armband for 9.8 ± 0.9 days for 23.2 ± 0.8 h/d.

2.4. Statistical analyses

All analyses were performed using SAS (version 9.4; SAS, Cary, NC, USA). Population characteristics were compared across DII quartiles using χ^2 test for categorical measures or trend tests for continuous measures. Pearson correlations were performed for the DII, HEI-2010, AHEI, and DASH using the scores as continuous variables. Variable selections began as a series of bivariate analyses (ie, exposure + potential covariate) where covariates with a *P* value of .20 or less were added to a "full" model. Backward confounder selections produced "final" models that included all covariates that were statistically significant ($P < .05$); covariates that changed the β coefficient of the exposure by at least 10% also were retained. Least square means and 95% confidence intervals of the HEI-2010, AHEI, and DASH were calculated among quartiles of the DII using general linear models. Considering diet can differ according to sex, all analyses were stratified by sex.

3. Results

Among all participants (men: n = 212, women: n = 218), the average age was 27.7 ± 3.8 years, BMI was 25.4 ± 3.8 kg/m^2, and total physical activity hours per day was 5.9 ± 1.5 hours with an average of 7661 ± 2738 steps per day. Most participants completed college (84%), had an income lower than $60 000 (72%), and were European American (67%). Those in DII quartile 4 (ie, more proinflammatory) compared with quartile 1 were more likely to be male (59% vs 38%, $P = .01$), have less than a completed college education (27% vs 9%, $P < .01$), and have children (24% vs 11%, $P = .03$). Significant trends were observed for age (increased across DII quartiles, $P = .01$), WHR (increased across DII quartiles, $P = .04$), and cognitive restraint for eating (decreased across DII quartiles, $P < .01$; Table 1).

The DII was negatively correlated with the HEI-2010 ($r = -0.65$, $P < .01$), AHEI ($r = -0.55$, $P < .01$), and the DASH ($r = -0.52$, $P < .01$; data not tabulated). As hypothesized, compared with DII quartile 4, those in DII quartile 1 had healthier scores for the HEI-2010 (66.2 vs 48.2, $P < .01$), AHEI (53.8 vs 39.0, $P < .01$), and DASH (25.5 vs 19.9, $P < .01$) after adjustment for a variety of factors (see footnotes of Table 2 for list of adjustments). Statistically significant ($P < .01$) linear associations also were observed between continuous DII scores and each of the dietary indices presented above (data not tabulated). Trend tests also were statistically significant ($P < .01$ for all models). After further stratification by sex, the results appeared to be consistent among the male and female subgroups and mirrored results observed among all participants (Table 2).

4. Discussion

This study accepted the hypothesis by finding that more anti-inflammatory DII scores (ie, more negative) were associated with healthier values on the HEI-2010, AHEI, and DASH indices. All 4 dietary indices take into account the complexity of diet as a whole. Use of dietary indices considers the fact that foods are eaten in combination and obviates the limitation that single nutrients may not reflect the overall quality of the diet. In addition, single nutrients may be highly correlated and it may not be possible to separate out individual effects, or the effect of any single nutrient may be too small to observe. Lastly, examining a large number of individual food constituents may lead to chance findings [20].

The DII was derived from peer-reviewed literature by examining the relationship between dietary factors and inflammation to determine the inflammatory potential of diet which is a major risk factor for many chronic diseases. Although the DII is distinctly different in its nature compared with these other dietary indices in what it represents and how it is scored, there is a good level of agreement between all indices.

Findings from this study are consistent with those from a randomized control trial designed to test the effect of dietary regimens that differ in terms of food group and nutrient intake (participants were randomized into vegan, vegetarian, pesco-vegetarian, semivegetarian, and omnivorous diets). Compared with baseline DII values, DII values after that 2-month intervention were lower (ie, more anti-inflammatory) for the vegan (mean DII, 0.3 vs −1.2), vegetarian (mean DII, 0.4 vs −1.0), and pesco-vegetarian (0.9 vs −0.7) diets [11]. In a simulation analysis of fast food, Mediterranean, and macrobiotic diets, the DII was +4.0 for the fast food diet, −4.0 for the Mediterranean diet, and −5.5 for the macrobiotic diet [12].

In addition to the main findings, there were some notable findings relating the DII to various sociodemographic or psychosocial constructs. Females, participants with more education (4+ years of college), and those who were older had more anti-inflammatory diets. Two US studies, using the HEI-2005, also indicated better dietary quality among females, those who were older, and those with more education [21,22]. In addition, in an analysis of diet quality from 187 countries, females and those who were older had better dietary quality [23]. However, it should be noted that the age range in the current study was relatively narrow and nearly all participants had at least some college education; direct comparison to these other studies may not be entirely appropriate.

Individuals with lower WHR had statistically significantly lower DII values. Not surprisingly, diet quality tends to be healthier among those with lower body weights or BMI [24]. It is interesting to note that WHR is a measure of intra-abdominal adiposity, a factor strongly associated with inflammation [25], the basis of the DII. Lastly, lower DII scores were associated with higher values for the Drive for Thinness subscale (ie, concern with dieting, weight, and fear of weight gain) of the EDI and the Cognitive Restraint subscale (ie, ability to limit intake and achieve weight loss or control) of the TFEQ. Conceptually, these findings make logical sense; those who have more control over their eating or are actively trying to lose weight will tend to consume less energy-dense unhealthy foods and/or more anti-inflammatory foods (eg, fruits and vegetables).

This analysis was subject to a couple of limitations. For one, the study population was primary young, European American, and highly active; thus, results may not be generalizable to other populations. These indices were based on 24HR data and the composition of some of the subcomponents of each index may differ compared with other studies using different dietary assessment methods. In addition, as with other dietary reporting tools, the 24HR is subject to reporting bias, as it is based on self-report. Despite the limitations, this analysis made use of a wide range of covariate information available for confounder selection, including measures such as social desirability and approval, which have been shown to bias dietary self-reports [26]. The 24HR is subject to less error than structured questionnaires [27] and its use allowed for inclusion of most of the food parameters comprising the DII; this is oftentimes not the case with food frequency questionnaires. Also, 97% of participants underwent at least two 24HRs, which contributes to the overall stability of the estimates [28].

In conclusion, this analysis showed that more anti-inflammatory DII scores are associated with healthier scores on several widely used dietary indices. However, the agreement between the DII and the other indices was around 0.55, which is good, but nowhere near perfect. Clearly, the DII accounts for different sources of variability, presumably related to inflammation, providing additional valuable information beyond other commonly used dietary indices. The DII was found to have good agreement with other dietary indices and may have the added benefit of capturing information on a particular aspect of diet (ie, inflammatory potential) that is directly relevant to the development of many chronic diseases [29] including cancer and cardiovascular disease [3]. As it relates to human nutrition and health, the DII may serve as a useful tool that helps individuals choose more anti-inflammatory foods and meals which has the added benefit of helping individuals lower chronic inflammation, and in turn, chronic inflammatory-related disease risk or recurrence.

Conflicts of Interest

James R. Hébert owns controlling interest in Connecting Health Innovations LLC (CHI), a company planning to license the right to his invention of the 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. Michael D. Wirth and Nitin Shivappa are employees of CHI. Steven N. Blair has served on the scientific advisory boards of Technogym, Clarity, Cancer Foundation for Life, and Santech. He has received research funding from BodyMedia, Technogym, The Coca-Cola Company, the US Department of Defense, and the National Institutes of Health. He receives book royalties from Human Kinetics.

Acknowledgment

Funding for this project was provided through an unrestricted grant from The Coca-Cola Company. The Coca-Cola Company played no role in the study design, collection, analysis and interpretation of data, or preparation and submission of this manuscript. J.R.H., M.D.W., and N.S. were supported by Grant No. R44DK103377 from the US National Institute of Diabetes and Digestive and Kidney Diseases. The authors thank the participants, the Energy Balance staff, and the External Advisory Board for their participation in this study.

REFERENCES

[1] Ahluwalia N, Andreeva VA, Kesse-Guyot E, Hercberg S. Dietary patterns, inflammation and the metabolic syndrome. Diabetes Metab 2013;39:99–110.

[2] Lee H, Lee IS, Choue R. Obesity, inflammation and diet. Pediatr Gastroenterol Hepatol Nutr 2013;16:143–52.
[3] Libby P. Inflammatory mechanisms: the molecular basis of inflammation and disease. Nutr Rev 2007;65:S140–6.
[4] Shivappa N, Steck SE, Hurley TG, Hussey JR, Hebert JR. Designing and developing a literature-derived, population-based dietary inflammatory index. Public Health Nutr 2014;17:1689–96.
[5] Shivappa N, Steck SE, Hurley TG, Hussey JR, Ma Y, Ockene IS, et al. A population-based dietary inflammatory index predicts levels of C-reactive protein in the Seasonal Variation of Blood Cholesterol Study (SEASONS). Public Health Nutr 2014;17:1825–33.
[6] Wirth MD, Burch J, Shivappa N, Violanti JM, Burchfiel CM, Fekedulegn D, et al. Association of a dietary inflammatory index with inflammatory indices and metabolic syndrome among police officers. J Occup Environ Med 2014;56:986–9.
[7] Tabung FK, Steck SE, Zhang J, Ma Y, Liese AD, Agalliu I, et al. Construct validation of the dietary inflammatory index among postmenopausal women. Ann Epidemiol 2015;25:398–405.
[8] Wirth MD, Shivappa N, Steck SE, Hurley TG, Hebert JR. The dietary inflammatory index is associated with colorectal cancer in the National Institutes of Health–American Association of Retired Persons Diet and Health Study. Br J Nutr 2015;113:1819–27.
[9] Ruiz-Canela M, Zazpe I, Shivappa N, Hebert JR, Sanchez-Tainta A, Corella D, et al. Dietary inflammatory index and anthropometric measures of obesity in a population sample at high cardiovascular risk from the PREDIMED (PREvencion con DIeta MEDiterranea) trial. Br J Nutr 2015;113:984–95.
[10] Wood LG, Shivappa N, Berthon BS, Gibson PG, Hebert JR. Dietary inflammatory index is related to asthma risk, lung function and systemic inflammation in asthma. Clin Exp Allergy 2015;45:177–83.
[11] Turner-McGrievy GM, Wirth MD, Shivappa N, Wingard EE, Fayad R, Wilcox S, et al. Randomization to plant-based dietary approaches leads to larger short-term improvements in Dietary Inflammatory Index scores and macronutrient intake compared with diets that contain meat. Nutr Res 2015;35:97–106.
[12] Steck SE, Shivappa N, Tabung FK, Harmon BE, Wirth MD, Hurley TG, et al. The Dietary Inflammatory Index: a new tool for assessing diet quality based on inflammatory potential. The Digest: The Research Dietetic Practice Group of the Academy of Nutrition and Dietetics 2014;49:1–9.
[13] Fung TT, Chiuve SE, McCullough ML, Rexrode KM, Logroscino G, Hu FB. Adherence to a DASH-style diet and risk of coronary heart disease and stroke in women. Arch Intern Med 2008; 168:713–20.
[14] Guenther PM, Casavale KO, Reedy J, Kirkpatrick SI, Hiza HA, Kuczynski KJ, et al. Update of the Healthy Eating Index: HEI-2010. J Acad Nutr Diet 2013;113:569–80.
[15] McCullough ML, Feskanich D, Stampfer MJ, Giovannucci EL, Rimm EB, Hu FB, et al. Diet quality and major chronic disease risk in men and women: moving toward improved dietary guidance. Am J Clin Nutr 2002;76:1261–71.
[16] Hand GA, Shook RP, Paluch AE, Baruth M, Crowley EP, Jaggers JR, et al. The energy balance study: the design and baseline results for a longitudinal study of energy balance. Res Q Exerc Sport 2013;84:275–86.
[17] Cohen S, Kamarck T, Mermelstein R. A global measure of perceived stress. J Health Soc Behav 1983;24:385–96.
[18] Garner DM, Olmstead MP, Polivy J. Development and validation of a multidimensional eating disorder inventory for anorexia-nervosa and bulimia. Int J Eat Disord 1983;2:15–34.
[19] Stunkard AJ, Messick S. The Three-Factor Eating Questionnaire to measure dietary restraint, disinhibition and hunger. J Psychosom Res 1985;29:71–83.
[20] Hu FB. Dietary pattern analysis: a new direction in nutritional epidemiology. Curr Opin Lipidol 2002;13:3–9.
[21] Hiza HA, Casavale KO, Guenther PM, Davis CA. Diet quality of Americans differs by age, sex, race/ethnicity, income, and education level. J Acad Nutr Diet 2013;113:297–306.
[22] Hsiao PY, Mitchell DC, Coffman DL, Allman RM, Locher JL, Sawyer P, et al. Dietary patterns and diet quality among diverse older adults: The University of Alabama at Birmingham Study of Aging. J Nutr Health Aging 2013;17:19–25.
[23] Imamura F, Micha R, Khatibzadeh S, Fahimi S, Shi PL, Powles J, et al. Dietary quality among men and women in 187 countries in 1990 and 2010: a systematic assessment. Lancet Glob Health 2015;3:E132–42.
[24] Pate RR, Ross SET, Liese AD, Dowda M. Associations among physical activity, diet quality, and weight status in US adults. Med Sci Sports Exerc 2015;47:743–50.
[25] Jeffcoat R. Obesity—a perspective based on the biochemical interrelationship of lipids and carbohydrates. Med Hypotheses 2007;68:1159–71.
[26] Hebert JR, Clemow L, Pbert L, Ockene IS, Ockene JK. Social desirability bias in dietary self-report may compromise the validity of dietary-intake measures. Int J Epidemiol 1995;24: 389–98.
[27] Hebert JR, Ebbeling CB, Matthews CE, Hurley TG, Ma Y, Druker S, et al. Systematic errors in middle-aged women's estimates of energy intake: comparing three self-report measures to total energy expenditure from doubly labeled water. Ann Epidemiol 2002;12:577–86.
[28] Ma Y, Olendzki BC, Pagoto SL, Hurley TG, Magner RP, Ockene IS, et al. Number of 24-hour diet recalls needed to estimate energy intake. Ann Epidemiol 2009;19:553–9.
[29] Fung TT, Brown LS. Dietary patterns and the risk of colorectal cancer. Curr Nutr Rep 2013;2:48–55.