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Adherence to the dietary guidelines for Americans and endometrial cancer risk

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Abstract

The Healthy Eating Index (HEI) was developed by the US Department of Agriculture with the goal of quantifying adherence to the Dietary Guidelines for Americans. The purpose of this study was to evaluate the impact of the HEI-2005 score and each of its components on endometrial cancer risk in a population-based case–control study in New Jersey. A total of 424 cases and 398 controls completed a Food Frequency Questionnaire, which was used to derive the HEI-2005 score. Odds ratios (OR) and 95% confidence intervals (CI) were calculated using unconditional logistic regression while adjusting for potential covariates, which included all major endometrial cancer risk factors. The adjusted OR for women in the highest quartile when compared to the lowest quartile was 0.83 (95% CI: 0.52–1.34). For the meat and beans component comprising meat, eggs, poultry, fish, and beans, the OR was 0.70 (95% CI: 0.45–1.11; *p* for trend: 0.07), with little evidence of an association with any of the individual foods. There was no indication of an association for any of the other components of the HEI or of effect modification by body mass index. This study suggested limited value for the HEI-2005 in predicting endometrial cancer risk.

Keywords

Diet; Endometrial cancer; Food; Healthy Eating Index; Fruit; Vegetables; Grain; Whole grain; Dairy; Meat; Beans; Oils; Saturated fat

Introduction

Endometrial cancer is the most common cancer of the female reproductive system and accounts for six percent of all cancers in women in the United States (US). The National Cancer Institute estimated 42,160 new cases of endometrial cancer and 7,780 deaths in 2009 in the United States [1]. Endometrial exposure to unopposed estrogen has been implicated as the main risk factor for endometrial cancer [2,3]. Hence, factors that increase estrogen

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exposure such as late menopause, nulliparity, obesity, and unopposed estrogen use have all been shown to increase endometrial cancer risk.

Obesity as measured by body mass index has been shown to have the most impact on endometrial cancer risk [4], and this association is consistent in women across ethnic groups [5]. Closely related to adult adiposity are dietary factors that have been growing in importance with corresponding growth in obesity trends. Dietary factors could also influence endogenous hormone levels, thus providing a biological basis for further investigation. An expert review for the WCRF/AICR Second Report on Food, Nutrition, Physical Activity, and the Prevention of Cancer [6] confirmed well-established associations of endometrial cancer with body mass index and weight and concluded that more research was needed to fully understand the impact of diet on endometrial cancer risk [7]. Although several epidemiologic studies have explored this association, traditionally these studies have focused on evaluating associations between individual food items or nutrients and disease risk. However, the advantage of using a dietary index such as the Healthy Eating Index (HEI) to evaluate cancer risk is the potential to account for the multidimensional character of an individual's diet as compared to evaluating a single nutrient.

The Healthy Eating Index (HEI) is a dietary assessment tool developed by the U.S. Department of Agriculture (USDA) based on specific recommendations in the Dietary Guidelines for Americans and the Food Guide Pyramid to assess the extent to which people's diets adhere to dietary recommendations [8]. The original HEI was released in 1995 and comprised 10 components based on the Food Guide Pyramid [9]. The HEI was revised in 2005 after the release of the 2005 Dietary Guidelines to incorporate the emphasis on other aspects of dietary quality not covered in the original HEI, such as whole grains, vegetable subgroups, specific types of fat, and the new concept of “discretionary calories” [10]. The revised HEI (HEI-2005) comprises 12 food components for a total score of 100 points and represents intakes of foods and nutrients using a density approach, expressed as a percent of calories or per 1,000 calories. The original HEI report provided interpretation for thresholds such that scores of more than 80 indicated a “good” diet, scores between 51 and 80 indicated a diet that “needs improvement,” and scores of less than 51 indicated a “poor” diet [9].

Previous studies that have utilized a dietary index to predict cancer risk have reported inconsistent findings [11-15]. To our knowledge, only four studies have evaluated the association between HEI and cancer, two on breast cancer [15,16] and two on colorectal cancer [11,17]. This is the first study to evaluate the association between a composite score as derived from the HEI-2005 and endometrial cancer risk.

Methods

We evaluated the association between the HEI-2005 and endometrial cancer risk in the EDGE Study (Estrogen, Diet, Genetics, and Endometrial Cancer), a population-based study based in Northern New Jersey. Methods in this study have been described in detail elsewhere [18-20]. In brief, the source population for the EDGE study comprised women older than 21 years living in one of these six NJ counties (Bergen, Essex, Hudson, Middlesex, Morris, and Union) and able to understand English or Spanish. A case event was defined as a newly diagnosed and histologically confirmed epithelial endometrial cancer identified between 1 July, 2001 and 30 June, 2005. Cases were identified through rapid case ascertainment implemented by the New Jersey Department of Health and Senior Services in addition to state cancer registry data for cases diagnosed outside the six given counties. A total of 1,559 eligible cases were identified; 1,104 were contacted within a year of diagnosis, of whom 469 women (42%) participated in data collection.

The control group was gathered from different sources. Controls had the same eligibility as the cases in addition to not having had a hysterectomy. Random digit dialing was employed to locate women under 65 years of age, of whom 355 women were eligible to participate. Data were collected from about 49% of these women. Potential participants from women aged 65 and older were identified through random selection from lists purchased from the Centers for Medicare and Medicaid (CMS). This process identified 316 women, of whom 68 (22%) agreed to participate. To recruit additional controls, an area sampling approach was initialized in August 2003 to locate women aged 65 and older, which was later expanded to include women aged 55 and older. Neighborhoods for the area sampling were randomly selected, and 30 consecutive households in each neighborhood were contacted by mail and in person. This process resulted in identifying 524 eligible controls, of whom 224 (43%) agreed to participate. A total of 467 controls were thus obtained. The study was approved by the institutional review boards at all participating institutions: Robert Wood Johnson Medical School, Memorial Sloan-Kettering Cancer Center, and the New Jersey Department of Health and Senior Services.

Data collection

Data collection in cases and controls included telephone and self-administered questionnaires. The telephone interview collected information on established and potential risk factors for endometrial cancer. The mailed package included instructions for providing a mouthwash specimen and waist and hip circumferences along with the Block 98.2 Food Frequency Questionnaire (FFQ). The FFQ queried about usual intake of the requested food items during six months before diagnosis (for cases) or on the date of interview (for controls).

The Block 98.2 FFQ utilized for dietary data collection by this study was developed from the NHANES III (National Health and Nutrition Examination Survey) dietary recall data to estimate usual intake of a variety of nutrients and food groups. The FFQ includes 110 food items and questions on individual portion size for each food item, and pictures are provided to enhance the accuracy of estimation. Completed FFQs were returned by a total of 424 cases (90.4%) and 398 controls (85.2%). The participants who returned the FFQ tended to be older, but there were no significant differences in education, BMI, unopposed Estrogen Replacement Therapy (ERT) use, or Hormone Replacement Therapy (HRT) use (data not shown). Berkeley Nutrition Services provided nutrient calculations using the USDA Nutrient Database for Standard Reference [21].

Compilation of the Healthy Eating Index (HEI) 2005

The HEI-2005 consists of 12 components (see Appendix 1) that represent all of the major food groups found in My Pyramid—total fruit, total vegetables; total grains; milk; and meat and beans [8, 10]. These food groups were retained from the original HEI. Additional components were included in the HEI-2005 to reflect the quality of the diet—whole fruit, dark green and orange vegetables; whole grains; oils (non-hydrogenated vegetable oils and oils in fish, nuts, and seeds); and added calories from solid fat, alcohol, and added sugar. Saturated fat and sodium were also retained as food components from the previous HEI.

HEI component scores

To calculate component scores as per HEI-2005, we used food consumption values obtained from the FFQ to derive cup equivalents for total fruit, whole fruit, total vegetables, dark green and orange vegetables, and milk, and ounce equivalents for total grains, whole grains, and the meat and beans component. Food nutrient measures obtained from the Block 98.2 FFQ were converted to cup or ounce equivalents to render them suitable for computing the HEI-2005. Conversion values for the nutrients were obtained from the USDA National

Nutrient Database for Standard Reference [21] and USDA's What's in the foods you eat, Search Tool 3.0 database [22]. For example, the original index utilized daily servings of fruits when compared to daily cup equivalents utilized by the HEI-2005. Since one half cup of whole fruit is equivalent to one serving; the whole fruit serving variable was multiplied by 2 to obtain the cup equivalent. Other studies that have calculated the HEI-2005 index based on nutrient measures obtained from the Block 98.2 FFQ utilized these same resources to compute component values [23,24].

The meat and beans component included servings of meat, fish, poultry, beans, and eggs [10]. Total cups of dark green and orange vegetables were calculated as sum of daily cup equivalents of broccoli, carrots, spinach, mustard greens, turnip greens, collards, sweet potatoes, and green salad [25]. The oils group was calculated as a sum of omega3 fatty acids, monounsaturated, and polyunsaturated fats in grams. Sodium and saturated fat were also derived in grams based on reported dietary intake of foods in the FFQ. Finally, the total calories from solid fat, alcoholic beverages, and added sugar (SoFAAS component) included "total excess fat in grams and included all excess fats beyond what would be consumed if only the lowest forms of fats were eaten" [10] for these foods: milk, cheese, salad dressing, beef, pork, fried chicken, baked chicken, hot dogs, lunch meats, snacks, cake, cookies, and ice cream. In addition, fat (in grams) consumed from butter, margarine, and cream added to tea and/or coffee was included in calories obtained from solid fat. Cup and ounce equivalents for the various food components and the fat values for calculating the SoFAAS component were obtained from the USDA [21,26] and the National Heart, Lung, and Blood Institute [27]. Finally, calories obtained from alcoholic beverages and added sugar were added to solid fat calories to obtain total calories for the SoFAAS group. Added sugar values in grams were obtained from the USDA database [28] for added sugar content in the following foods in the FFQ: sugar added to tea and coffee, juice drinks, drinks with added vitamin C, breakfast milkshakes, regular soft drinks, canned fruit, pancakes, waffles, pop tarts, breakfast bars, cold cereal, yogurt, salad dressing, doughnuts, pastries, cakes, sweet rolls, ice cream, cookies, pies, candy bars, muffins, bagels, peanut butter, jelly, jams, and syrup. Each of the food components (except for saturated fat and SoFAAS) was then converted to represent intakes of foods and nutrients on a density basis, i.e., as amounts per 1,000 calories of intake. The individual component scores were calculated according to scoring standards (shown in Appendix 1) and SAS protocols provided by the USDA [29].

The overall score for the HEI-2005 and individual component scores were derived by assigning a maximum, minimum, or pro-rated value for the respective nutrient density measures. Scores for saturated fat and the SoFAAS group were assigned based on a calculated percentage of total energy intake. Values for the HEI-2005 index range from 0–100, with a higher value representing a healthier diet. The maximum score for total fruit, whole fruit, total vegetables, dark green and orange vegetables, total grains, and whole grains is 5 points, while the maximum score for milk, meat and beans, saturated fat, oils, and sodium components is 10 points. Individuals could obtain a maximum score of 20 points for the SoFAAS component. The minimum score for all 12 components is 0.

Statistical analyses

Descriptive statistics for demographics and major risk factors were derived to evaluate the distribution of these factors among cases and controls. Age-adjusted means were calculated for cases and controls for each of the 12 density measures and the overall index and compared using analysis of covariance. Each of the density standards and the overall HEI score variable were categorized into quartiles based on the distribution among controls. Unconditional logistic regression analyses were conducted to estimate odds ratios and 95% confidence intervals for quartiles of the 12 components and the overall score. We used a spline technique that modeled the association between age and case–control status separately

according to three age categories: <65, 65 to <80, and 80+ years in logistic models [30]. Covariates considered included age, education, race, age at menarche, menopausal status and age at menopause for postmenopausal women, parity, oral contraceptive use, hormone replacement therapy use, body mass index (continuous), total energy intake, physical activity (in metabolic equivalents or METs), smoking status, and alcohol (g/1,000 kcal). Tests for trend were computed by assigning the median value to each quartile.

Stratified analyses were conducted to assess the role of obesity as an effect modifier. Interactions were evaluated using cross-product terms in logistic regression models.

All analyses were completed using SAS version 9.2 (SAS Institute, Cary NC).

Results

Descriptive statistics for the study population and the distribution of risk factors for cases and controls are shown in Table 1. The mean age was 61.6 years for cases and 64.3 years for controls ($p = 0.02$). Overall, consistent with other studies, obesity was strongly associated with increased risk for endometrial cancer, while current smoking, parity, and oral contraceptive use appeared to decrease endometrial cancer risk. Age-adjusted mean values for the HEI-2005 score as well as individual food components in cases and controls are shown in Table 2. The age-adjusted mean values for the overall HEI-2005 score, total fruit, whole fruit, total vegetables, dark green and orange vegetables, whole grains, dairy, meat and beans, and oils were lower for cases when compared to controls; although the mean difference was borderline significant only for the whole fruit component and for the dairy component. The age-adjusted mean values for total grain, saturated fat, sodium, and SoFAAS were marginally higher for cases when compared to controls. However, none of these mean differences were statistically significant.

Endometrial cancer risk estimates associated with the HEI-2005 score and its individual components are shown in Table 3. As mentioned earlier, by convention, a HEI score of more than 80 indicates a “good” diet, scores between 51 and 80 indicate a diet that “needs improvement,” and scores of less than 51 indicate a “poor” diet [9]. Using these cutpoints, only 11 cases and 7 controls were in the “poor” diet category, with 85% of the cases and 83% of the controls being in the “needs improvement” category. Because this was not an optimal distribution, we decided to categorize the HEI score variable in quartiles (Table 3). The OR for the highest vs. the lowest quartile of the HEI-2005 score was below one, but the 95% confidence interval included the null value (OR = 0.83, 95% CI: 0.52–1.34). Nevertheless, we also computed the OR comparing a HEI-2005 score of >80 (“good diet”) vs. <51 (“poor diet”), with similar results (OR: 0.64; 95% CI: 0.20–2.05) (data not shown).

Overall, there was little evidence for a statistically significant association between any of the individual food components and endometrial cancer risk (Table 3). Although the point estimates for the highest vs. the lowest quartile of total fruit, whole fruit, total vegetable, total grain, whole grain, dairy, meat and beans, oils, saturated fat, and sodium were below one, the confidence intervals included the null value. For the meat and beans component, the OR was 0.70 (95% CI: 0.45–1.11; p for trend: 0.07). We also analyzed separately the foods included in the meat and beans component. We did not find any significant associations with any of the foods, although the effect estimates for the highest quartiles of fish, beans, and legumes when compared to the lowest quartiles were below one or close to one (data not shown). For red meat, the OR for the highest quartile compared to the lowest was above one, but there was little evidence of an association (OR = 1.11, 95% CI: 0.70–1.75).

To evaluate whether an individual's body mass index (BMI) modified the relationship between HEI score and endometrial cancer, stratified analyses were conducted. Although

risk estimates for the highest HEI score category were of different magnitude in normal, overweight, and obese women, the confidence intervals overlapped, and the *p* for interaction was not statistically significant ($p = 0.11$; data not shown). Overall, our analyses provided little support for effect modification by BMI.

Discussion

In this study, adherence to the Dietary Guidelines of Americans, as measured by the HEI-2005 score showed limited value for endometrial cancer prevention. To further explore this issue, each individual food component that constituted the index was separately analyzed. However, there was little indication that any of the other components had a major impact on endometrial cancer risk.

The Healthy Eating Index (HEI) 2005 has been modified from its previous version to emphasize the quality of an individual's diet rather than quantity. Existing literature on adherence to dietary guidelines has shown decreased risk of colorectal cancer (with the HEI-2005) [11,17], decreased BRCA-associated breast cancer risk (with the revised Diet Quality Index and Canadian HEI) [15], and decreased depression symptoms in breast cancer survivors (with the original HEI) [31]. However, similar to our results, other studies that evaluated the ability of HEI in predicting chronic disease [32-34] and breast cancer risk [16] also commented on the index's limited potential for offering optimal dietary guidance.

The risk estimate for the “meat and beans” component (which included meat, fish, poultry, beans, and eggs) was below one, but the confidence interval included one. Because these foods may have opposite effects, we evaluated each food group separately, with little evidence of an association for any of them. A systematic literature review and meta-analysis reported an increased risk between red meat and endometrial cancer, with an estimate of 51% increased risk per 100 g/day of red meat consumed [35]. However, consistent with other studies conducted in the United States and Canada [36-39], we found no evidence of an association with red meat. There has been a growing interest in the role of phytoestrogens, which are high in beans, on endometrial cancer risk. However, the two studies conducted in non-Asian populations in the United States failed to find an association [19,40].

Case–control studies evaluating the effect of vegetables on endometrial cancer risk have generally supported a weak inverse association [41]. However, as in our study, no association with total vegetables or with major vegetable groups was observed in the only prospective cohort evaluating this association [42].

Several limitations of this study should be mentioned. Not unlike other epidemiologic studies, our study had a low response rate. To evaluate potential selection bias in our cases, we compared those who participated to all women diagnosed with endometrial cancer in the respective counties during the same time period. The cases included in the study were more likely to be younger and diagnosed with localized disease. For controls, we do not have information on those who could not be reached or did not participate; however, the distribution of the main risk factors in cases and controls provides reassurance, as the odds ratios for these factors are similar to those reported in the literature on endometrial cancer. Furthermore, as with any case–control study, there is a concern for cases and controls to recall dietary information differently. However, because the role of dietary factors in the etiology of endometrial cancer is not well known, this is less likely than for other more widely known or more highly publicized associations.

In summary, to our knowledge, this is the first study that has evaluated the role of adherence to the USDA Dietary Guidelines for Americans, as measured by the HEI-2005 on

endometrial cancer risk. Overall, while the HEI-2005 may be a useful measure of an individual's dietary quality, its value in predicting endometrial cancer risk is uncertain at the present time.

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Appendix 1

See Table 4.

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Table 1

Select characteristics of cases and controls participating in the EDGE study, New Jersey

	Cases (*n* and %) total: 417	Controls (*n* and %) total: 395	OR* (95% CI)
Race/Ethnicity			
White	355 (85.4%)	349 (88.8%)	1.00 (Ref)
Black	36 (8.6%)	17 (4.3%)	1.96 (1.08–3.57)
Hispanic (any race)	15 (3.6%)	11 (2.8%)	1.14 (0.51–2.54)
Other	10 (2.4%)	116 (4.1%)	0.54 (0.24–1.21)
Education			
High school or less	154 (36.9%)	134 (33.9%)	1.00 (Ref)
College	183 (43.9%)	158 (40.0%)	0.92 (0.66–1.27)
Graduate school (>college)	80 (19.2%)	103 (26.1%)	0.60 (0.41–0.88)
BMI (kg/m^2)			
Normal (<25)	105 (25.2%)	189 (47.9%)	Ref (1.00)
Overweight(25–29.9)	121 (29.0%)	119 (30.1%)	1.93 (1.36–2.75)
Obese (30–34.9)	68 (16.3%)	62 (15.7%)	2.02 (1.32–3.08)
Very obese (≥35)	123 (29.5%)	25 (6.3%)	8.47 (5.16–13.89)
Parity			
0–1	147 (35.3%)	92 (23.3%)	1.00 (Ref)
2	142 (34.1%)	149 (35.4%)	0.64 (0.45–0.90)
3–4	128 (30.7%)	163 (41.3%)	0.53 (0.37–0.76)
Smoking status			
Never	231 (55.4%)	207 (52.7%)	1.00 (Ref)
Past	159 (38.1%)	148 (37.7%)	0.97 (0.72–1.30)
Current	27 (6.5%)	38 (9.7%)	0.58 (0.34–0.98)
Oral contraceptive use			
Never	224 (53.7%)	199 (50.4%)	1.00 (Ref)
Ever	193 (46.3%)	196 (49.6%)	0.69 (0.51–0.93)
Use of HRT			
Never	335 (80.3%)	291 (73.7%)	1.00 (Ref)
Unopposed estrogen only	34 (8.2%)	31 (7.9%)	0.97 (0.58–1.63)
Any combined HRT	48 (11.5%)	73 (18.5%)	0.54 (0.36–0.81)
Age at menarche			
>13	74 (17.8%)	102 (25.9%)	0.66 (0.46–0.95)
12–13	233 (56.0%)	198 (50.3%)	1.00 (Ref)
<12	109 (26.2%)	94 (23.9%)	0.93 (0.66–1.31)
Menopausal status			
Premenopausal	59 (14.2%)	48 (12.2%)	0.72 (0.42–1.24)
Postmenopausal			
Age at menopause			
<40	13 (3.1%)	12 (3.0%)	0.97 (0.43–2.21)
40–54	254 (60.9%)	243 (61.5%)	1.00 (Ref)

	Cases (*n* and %) total: 417	Controls (*n* and %) total: 395	OR* (95% CI)
≥ 54	41 (9.8%)	39 (9.9%)	1.11 (0.68–1.80)
Unknown	50 (12.0%)	53 (13.4%)	0.91 (0.59–1.40)

* OR adjusted for age

Table 2

Age-adjusted means for the HEI score and its components based on daily food consumption in cases and controls

Variables	Cases (*n* = 417) mean (SE)	Controls (*n* = 395) mean (SE)	*p* value
HEI-2005 (score 0–100)	70.69 (0.41)	71.40 (0.42)	0.22
Total fruit (daily cups/1,000 kcal)	1.44 (0.06)	1.48 (0.06)	0.66
Whole fruit (daily cups/1,000 kcal)	1.59 (0.08)	1.80 (0.08)	0.05
Total vegetables (daily cups/1,000 kcal)	4.20 (0.13)	4.32 (0.13)	0.54
Dark green/orange vegetables (daily cups/1,000 kcal)	0.53 (0.02)	0.56 (0.02)	0.32
Total grain (daily ounces/1,000 kcal)	2.32 (0.04)	2.30 (0.05)	0.75
Whole grain (daily ounces/1,000 kcal)	0.82 (0.04)	0.87 (0.04)	0.38
Dairy (daily cups/1,000 kcal)	0.62 (0.03)	0.69 (0.03)	0.06
Meat and beans (daily ounces/1,000 kcal)	0.36 (0.007)	0.37 (0.007)	0.30
Oils (daily grams per 1,000 kcal)	27.08 (0.33)	27.43 (0.34)	0.46
Saturated fat (daily grams per total cal)	19.28 (0.56)	18.01 (0.57)	0.12
Sodium (daily grams per 1,000 kcal)	1.40 (0.02)	1.39 (0.02)	0.72
Calories from solid fat, alcohol, and added sugar	292.42 (10.23)	274.33 (10.51)	0.22

Note: Meat and beans component includes meat, poultry, fish, eggs, and beans

Table 3

Association between the Healthy Eating Index score (HEI-2005) and its components and endometrial cancer risk

	Cases (*n*)	Controls (*n*)	OR1	95% CI	OR2	95% CI
HEI-2005						
1 (<66.30)	117	99	1.00		1.00	
2 (66.30–72.48)	112	98	1.19	0.78–1.83	1.21	0.70–1.88
3 (72.49–77.98)	118	99	1.32	0.85–2.04	1.32	0.85–2.06
4 (≥77.99)	70	99	0.89	0.56–1.41	0.83	0.52–1.34
p trend			*0.85*		*0.65*	
Total fruit[a]						
1 (<0.79)	120	99	1.00		1.00	
2 (0.79–1.24)	94	95	0.76	0.49–1.17	0.72	0.47–1.12
3 (1.25–1.95)	107	101	1.02	0.67–1.56	1.00	0.65–1.55
4 (≥1.96)	96	100	0.93	0.59–1.47	0.87	0.55–1.39
p trend			*0.97*		*0.81*	
Whole fruit[a*]						
1 (<0.64)	114	95	1.00		1.00	
2 (0.64–1.38)	114	97	1.18	0.77–1.80	1.10	0.71–1.71
3 (1.39–2.58)	96	95	1.07	0.69–1.67	1.00	0.64–1.58
4 (≥2.59)	75	96	0.90	0.56–1.44	0.81	0.50–1.32
p trend			*0.49*		*0.29*	
Total vegetables[a]						
1 (<2.56)	117	99	1.00		1.00	
2 (2.56–3.68)	91	99	0.77	0.50–1.19	0.76	0.49–1.19
3 (3.69–5.62)	118	99	1.09	0.71–1.67	1.12	0.72–1.73
4 (≥5.63)	91	98	0.89	0.57–1.39	0.93	0.59–1.48
p trend			*0.87*		*0.94*	
Dark green and orange vegetables[a]						
1 (<0.34)	113	96	1.00		1.00	
2 (0.34–0.41)	100	102	0.87	0.57–1.35	0.90	0.58–1.41
3 (0.42–0.76)	106	100	1.08	0.70–1.66	1.11	0.72–1.73
4 (≥0.77)	98	97	1.02	0.66–1.58	1.02	0.65–1.60
p trend			*0.72*		*0.77*	
Total grain[b]						
1 (<1.64)	97	98	1.00		1.00	
2 (1.64–2.23)	110	99	1.20	0.78–1.85	1.19	0.76–1.85
3 (2.24–2.89)	122	97	1.30	0.84–1.99	1.29	0.83–1.99
4 (≥2.90)	88	101	0.91	0.59–1.42	0.90	0.57–1.42
p trend			*0.65*		*0.64*	
Whole grain[b]						

	Cases (*n*)	Controls (*n*)	OR1	95% CI	OR2	95% CI
1 (<0.33)	123	101	1.00		1.00	
2 (0.33–0.66)	98	96	0.79	0.52–1.22	0.79	0.51–1.23
3 (0.67–1.17)	94	98	0.69	0.45–1.05	0.66	0.43–1.02
4 (≥1.18)	102	100	0.88	0.57–1.35	0.87	0.56–1.34
p trend			*0.64*		*0.60*	
Dairy[a]						
1 (<0.26)	122	97	1.00		1.00	
2 (0.26–0.57)	109	102	0.83	0.55–1.26	0.79	0.52–1.22
3 (0.58–0.98)	100	97	1.02	0.67–1.56	0.96	0.63–1.47
4 (≥0.99)	86	99	0.85	0.55–1.32	0.81	0.52–1.27
p trend			*0.67*		*0.53*	
Meat and beans[b]						
1 (<0.26)	100	99	1.00		1.00	
2 (0.26–0.34)	121	104	1.04	0.68–1.59	1.06	0.69–1.63
3 (0.35–0.44)	101	93	0.84	0.54–1.31	0.84	0.54–1.32
4 (≥0.45)	95	99	0.71	0.45–1.11	0.70	0.45–1.11
p trend			*0.08*		*0.07*	
Oils[c]						
1 (<22.16)	89	99	1.00		1.00	
2 (22.16–27.07)	115	99	1.27	0.82–1.97	1.33	0.85–2.07
3 (27.08–31.37)	113	99	1.10	0.70–1.71	1.11	0.71–1.75
4 (≥31.38)	100	98	0.92	0.59–1.45	0.94	0.59–1.48
p trend			*0.52*		*0.56*	
Saturated fat[d]						
1 (<11.1)	82	97	1.00		1.00	
2 (11.1–16.1)	117	100	1.09	0.69–1.72	1.04	0.65–1.66
3 (16.2–22.0)	102	99	0.88	0.54–1.45	0.86	0.52–1.43
4 (≥22.1)	116	99	0.78	0.41–1.49	0.82	0.43–1.58
p trend			*0.30*		*0.43*	
Sodium[c]						
1 (<1.21)	107	97	1.00		1.00	
2 (1.21–1.34)	106	104	0.92	0.61–1.40	0.94	0.61–1.45
3 (1.35–1.52)	99	97	0.73	0.47–1.14	0.71	0.46–1.12
4 (≥1.53)	105	97	0.87	0.57–1.34	0.86	0.55–1.34
p trend		*0.44*			*0.40*	
SoFAAS[e]						
1 (<141.77)	83	99	1.00		1.00	
2 (141.77–238.18)	124	98	1.68	1.08–2.62	1.69	1.08–2.66
3 (238.19–349.84)	94	99	1.18	0.73–1.91	1.17	0.71–1.94
4 (≥349.85)	116	99	1.45	0.85–2.49	1.57	0.87–2.84
p trend			*0.43*		*0.30*	

[*] missing $n = 30$

[a] density measure calculated as daily cups per 1,000 kcal

[b] density measure calculated as daily ounces per 1,000 kcal

[c] density measure calculated as daily grams per 1,000 kcal

[d] expressed in daily grams

[e] calories from solid fat, alcohol, and added sugar

OR1: adjusted for age (continuous), education, race, age at menarche (continuous), menopausal status and age at menopause for postmenopausal women, parity, OC use, HRT use, BMI (continuous), and total calories

OR2: further adjusted for physical activity (METs), smoking status, and alcohol (g/1,000 kcal)

Table 4

Healthy Eating Index 2005—components and standards for scoring [10]

Component	Maximum points	Standard for maximum score	Standard for minimum score of zero
Total fruit (includes 100% juice)	5	≥0.8 cup equiv. per 1,000 kcal	No fruit
Whole fruit (excludes juice)	5	≥0.4 cup equiv. per 1,000 kcal	No whole fruit
Total vegetables	5	≥1.1 cup equiv. per 1,000 kcal	No vegetables
Dark green and orange vegetables and legumes	5	≥0.4 cup equiv. per 1,000 kcal	No dark green and orange vegetables and legumes
Total grains	5	≥3.0 oz equiv. per 1,000 kcal	No grains
Whole grains	5	≥1.5 oz equiv. per 1,000 kcal	No whole grains
Milk	10	≥1.3 cup equiv. per 1,000 kcal	No milk
Meat and beans	10	≥2.5 oz equiv. per 1,000 kcal	No meat and beans
Oils	10	≥12 grams per 1,000 kcal	No oils
Saturated fat	10	≤7% of energy	≥15% of energy
Sodium	10	≤0.7 gram per 1,000 kcal	≥2.0 grams per 1,000 kcal
Calories from solid fat, alcoholic beverages, and added sugars	20	≤20% of energy	≥50% of energy