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ORIGINAL PAPER

Healthy eating index and ovarian cancer risk

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Abstract The evidence for a role of diet on ovarian cancer prevention remains inconclusive. While many studies have evaluated individual foods and food groups, the evaluation of a comprehensive dietary quality index for predicting cancer risk has received little attention. This study investigates the association between the Healthy Eating Index (HEI), which reflects adherence to the current USDA Dietary Guidelines for Americans and ovarian cancer risk in a population-based case–control study in New Jersey. A total of 205 cases and 390 controls completed the Block 98.2 food frequency questionnaire (FFQ) in addition to reporting on potential risk factors for ovarian cancer. FFQ data were then utilized to calculate the HEI score, and cup, ounce, gram, or caloric equivalents for the 12 different food groups comprising the index. In multivariate models, the OR for the highest tertile of the HEI score compared with the lowest (reflecting a better diet compared with a worse diet) was 0.90 (95% CI: 0.55–1.47). There was limited evidence for a statistically significant association between any of the 12 individual food components and ovarian cancer risk. Based on this study's results, neither individual food groups nor dietary quality showed potential for preventing ovarian cancer.

Keywords Diet · Ovarian cancer · Food · Healthy Eating Index · Fruit · Vegetables · Grain · Whole grain · Dairy · Meat · Beans · Oils · Saturated fat · Diet · Nutrition

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Abbreviations

OR	Odds Ratio
CI	Confidence Interval
FFQ	Food frequency questionnaire
BMI	Body mass index
WHR	Waist to hip ratio
HRT	Hormone replacement therapy
E	Estrogen
OC	Oral contraceptives

Introduction

Ovarian cancer is the deadliest of all gynecologic malignancies with dismal five-year survival rates (46% for all stages combined; 28% for advanced stage, in which 62% of the cases are diagnosed) [1]. The National Cancer Institute (NCI) estimates 21,880 new cases and 13,850 deaths from ovarian cancer in the United States in 2010 [2]. Risk factors for ovarian cancer include family history of the disease (specifically mutations in BRCA1 and BRCA2 genes), age, and nulliparity; while oral contraceptive use, higher parity, and tubal ligation have been shown to reduce risk [3–5]. Lifestyle factors such as diet [5–10], obesity [10, 11], physical activity [12–15], and smoking [16] have been explored for their impact on ovarian cancer due to their underlying hormonal mechanisms; however, the evidence remains inconclusive.

Although a plethora of studies have investigated the influence of consumption of certain individual foods on ovarian cancer prevention, studies evaluating an individual's diet as a whole in predicting cancer risk are sparse. Accounting for all aspects of an individual's diet when compared to assessing a single food group or nutrient could contribute to better understanding of a person's nutritional lifestyle and consequent health benefits. In the past, dietary indices such as the Healthy Eating Index (HEI) have been utilized to assess the collective impact of a variety of foods and nutrients on endometrial cancer [17], breast cancer [18], and colorectal cancer risks [19, 20] as well as to predict major chronic disease risk [21, 22].

The Healthy Eating Index-2005 developed by the United States Department of Agriculture (USDA) is computed on a 100-point analytic scale and is derived from 12 different components each representing an important food group that reflects the quality of an individual's dietary intake [23]. By convention, a HEI score of greater than 80 indicates a "good" diet, a score between 51 and 80 indicates a diet that "needs improvement", and a score of less than 51 indicates a "poor" diet [24] although this is not strictly emphasized for the HEI-2005 [23]. Utilizing the HEI to assess the impact of diet quality on cancer risk can expand our understanding of dietary factors and ovarian cancer prevention through a comprehensive evaluation of an individual's diet. Studies adopting the HEI have shown an inverse association for colorectal cancer risk [19] while demonstrating limited potential for endometrial cancer prevention [17]. To the best of our knowledge, this is the first study to assess the association of the HEI with ovarian cancer risk.

Methods

We evaluated the association between diet and ovarian cancer in the *NJ Ovarian Cancer Study*. This study builds upon the EDGE Study (Estrogen, Diet, Genetics, and Endometrial Cancer), a population-based case–control study based in New Jersey [25]. We retained controls from the EDGE Study and added ovarian cancer cases to form a new case–control study. Newly diagnosed, pathologically confirmed cases of invasive epithelial ovarian cancer were identified between January 2004 and May 2008 through rapid case ascertainment implemented by the New Jersey State Cancer Registry (NJSCR) staff. The NJSCR is a population-based SEER cancer registry that has collected data since 1978. Women older than 21 years of age, able to understand English or Spanish, and residing in one of six New Jersey counties (Bergen, Essex, Hudson, Middlesex, Morris, and Union) were eligible to participate. A total of 682 eligible cases were initially identified. Of them, 70 cases were not contacted because they were deceased ($n = 61$) or their physicians advised us not to contact them ($n = 9$). Additionally, 119 people were ineligible because they could not be reached, no longer met eligibility requirements, there was a communication barrier, or they reported some other medical condition that precluded participation. Of the 493 remaining cases, 252 consented to participate (51%) and 233 completed the interview (47%).

The controls in the EDGE Study served as the comparison group. Methods have been described in detail elsewhere [25–27]. In brief, controls had the same eligibility criteria as the cases except that women with a history of hysterectomy and/or bilateral oophorectomy were excluded from the analysis. They were interviewed between January 2002 and December 2005. Random digit dialing was employed to recruit women under 65 years of age of whom 355 were eligible to participate and 175 completed the interview. Women older than 65 years were located through random selection by using lists purchased from the Center for Medicare and Medicaid Services (CMS); 68 women from this source completed the study. Finally, an area sampling approach identified 524 women older than 55 years of age who were eligible to participate, out of whom 224 completed the study. Overall, a total of 467 (40%) controls from the three sources completed the study.

Data collection

EDGE Study procedures, study materials, and questionnaires were also used for *NJ Ovarian Cancer Study* to maximize comparability between cases and controls. Once the case consented to participate, a telephone interview was scheduled. The telephone survey collected information on established and possible risk factors for ovarian cancer and recorded demographic characteristics. A package was sent to each participant that included mouthwash used to collect a buccal sample, and a tape measure was included to take anthropometric measures. Additionally, diet information was collected through the Block 98.2 food frequency questionnaire (FFQ) that included questions about usual intake of the requested food items during 6 months before diagnosis for cases or on the date of interview for controls.

The Block 98.2 FFQ (NutritionQuest, Berkeley, CA) developed from the National Health and Nutrition Examination Survey dietary recall data includes 110 food items and queries on frequency and portion size for each food item. Pictures were provided to enhance accuracy of estimation. A total of 205 cases and 390 controls completed the FFQ and were included in the study analyses.

Compilation of the Healthy Eating Index (HEI)

The Healthy Eating Index (HEI) revised in 2005 comprises 12 components (see Appendix) that represent not only the major food groups—total fruit, total vegetables, total grains, milk, and meat and beans, but also components that reflect dietary quality such as whole fruit, dark green and orange vegetables, whole grains, oils (non-hydrogenated vegetable oils and oils in fish, nuts, and seeds), saturated fat, sodium, and added calories from solid fat, alcohol, and added sugar [23, 28]. To calculate component scores as per HEI, we used food consumption values obtained from the FFQ to derive cup and ounce equivalents for the different food groups. Conversion values for the nutrients were obtained from the USDA National Nutrient Database for Standard Reference [29], USDA's What's in the foods you eat, Search Tool 3.0 database [30], and USDA's Myfood-a-pedia electronic resource [31]. USDA resources have been utilized by other studies for conversion of Block 98.2 FFQ measures into HEI component measures [32, 33]. The meat and beans component included servings of meat, fish, poultry, beans, and eggs [23]. 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 [34]. The oils group was calculated as a sum of omega-3 fatty acids, monounsaturated, and polyunsaturated fats in grams. In addition to questions on intake, the FFQ also queried about intake of fat for certain foods. For example, participants responding to frequency and serving of cheese intake were also asked to report if the cheese they ate was usually low fat, sometimes low fat, or hardly ever low fat. 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" [23]. Fat in grams for consumption of butter, margarine, and cream added to tea/coffee was also included in the SoFAAS group. Resources used to obtain fat values for the different foods in the FFQ were obtained from the USDA [29, 35] and the National Heart, Lung, and Blood Institute [36]. Added sugar values in grams were obtained from the USDA database [37] for the different foods included in the FFQ.

Each of the food components (except for saturated fat and SoFAAS) was then converted to represent the intake of foods and nutrients by density, i.e., as amounts per 1,000 calories of intake. The individual component scores were calculated according to scoring standards (shown in Appendix) and SAS protocols provided by the USDA [38]. Individuals were assigned a maximum, minimum, or prorated score based on their food and nutrient intake for each component. Individuals could obtain a maximum score of 100 on the HEI and a minimum score of 0. 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 tertiles based on the distribution among controls. Unconditional logistic regression analyses were conducted to estimate odds ratios and 95% confidence intervals for tertiles of the 12 components and the overall score. Covariates considered included age, education, race, age at menarche, menopausal status, parity, oral contraceptive use, hormone replacement therapy use, tubal ligation, body mass index (continuous), total energy intake (continuous), physical activity (in metabolic equivalents (or METs) for reported average hours per week of strenuous or moderate recreational activities), smoking status, and pack years smoked. Tests for trend were computed by assigning the median value to each tertile. All analyses were completed using SAS version 9.2 (SAS Institute, Cary NC).

Results

The mean ages (±standard deviation) for cases and controls were 57 (±10.4) and 64.6 (±10.9) years, respectively ($p < 0.001$). The characteristics of the study population are shown in Table 1. In Table 2, age-adjusted means of cases and controls for the HEI score and for each of the 12 components making up the index are shown. Mean HEI scores were very similar in cases and controls (69.52 and 69.84 for cases and controls, respectively; $p = 0.68$). Although the age-adjusted means for whole fruit, dark green and orange vegetables, whole grain, and meat and beans were slightly higher in controls than in cases, results only reached statistical significance for the meat and beans component ($p = 0.02$).

Table 1 Selected characteristics of cases and controls participating in the study

Characteristic	Cases ($n = 205$)	Controls ($n = 390$)	OR*
Education			
High school or less	61 (29.76)	132 (33.85)	Ref
College	93 (45.37)	159 (40.77)	0.90 (0.59–1.38)
Graduate school	51 (24.88)	99 (25.38)	0.76 (0.47–1.24)
Race			
White	179 (87.32)	343 (88.40)	Ref
Black	9 (4.39)	17 (4.38)	1.02 (0.42–2.44)
Other	8 (3.90)	17 (4.38)	0.82 (0.33–1.99)
Hispanic (any race)	9 (4.39)	11 (2.84)	1.13 (0.44–2.92)
Parity			
0–1	97 (47.32)	92 (23.59)	Ref
2	60 (29.27)	136 (34.87)	0.45 (0.29–0.69)
≥3	48 (23.41)	162 (41.54)	0.42 (0.26–0.66)
OC use			
Never	85 (41.46)	192 (49.23)	Ref
Ever	120 (58.54)	198 (50.77)	0.88 (0.61–1.28)
HRT use			
Never	159 (77.56)	284 (72.82)	Ref
Unopposed E only	22 (10.73)	34 (8.72)	1.56 (0.86–2.83)
Any combined HRT	24 (11.71)	72 (18.46)	0.63 (0.38–1.06)
Age at Menarche			
>13	41 (20.10)	98 (25.19)	0.81 (0.51–1.28)
12–13	117 (57.35)	200 (51.41)	Ref
≤11	46 (22.55)	91 (23.39)	0.75 (0.48–1.17)
Menopause			
Premenopausal	71 (34.63)	49 (12.56)	1.52 (0.85–2.70)
Age at menopause			
<40	5 (2.44)	14 (3.59)	0.77 (0.26–2.31)
41–54	86 (41.95)	239 (61.28)	Ref
≥55	12 (5.85)	36 (9.23)	0.99 (0.49–2.02)
Unknown	31 (15.12)	52 (13.33)	1.52 (0.91–2.56)
BMI			
Underweight (<18.5)	1 (0.49)	1 (0.26)	1.02 (0.06–17.31)
Normal (18.5–25)	90 (43.98)	179 (46.25)	Ref
Overweight (25–29.9)	54 (26.34)	122 (31.52)	1.07 (0.69–1.65)
Obese (30–34.9)	36 (17.56)	59 (15.25)	1.39 (0.83–2.32)
Very obese (≥ 35)	24 (11.71)	26 (6.72)	1.54 (0.82–2.89)
Smoking status			
Never	108 (52.68)	203 (52.05)	Ref
Past	78 (38.05)	149 (38.21)	1.12 (0.76–1.64)
Current	19 (9.27)	38 (9.74)	0.87 (0.46–1.62)
Tubal ligation			
Yes	30 (14.6)	76 (19.5)	0.59 (0.36–0.94)
No	175 (85.4)	314 (80.6)	Ref
First degree relative with ovarian cancer			
Yes	10 (4.9)	14 (3.6)	1.32 (0.55–3.17)
No	195 (95.1)	376 (96.4)	Ref

* OR adjusted for age

Table 2 Age-adjusted means of cases and controls for the HEI and its components based on daily food consumption

Variable	Cases (*n* = 205) Mean (SE)	Controls (*n* = 390) Mean (SE)	*p* value
HEI-2005 (score 0–100)	69.52 (0.63)	69.84 (0.45)	0.68
Total fruit (daily cups/1,000 kcal)	1.46 (0.09)	1.46 (0.07)	1.00
Whole fruit (daily cups/1,000 kcal)	1.59 (0.11)	1.77 (0.08)	0.20
Total vegetables (daily cups/1,000 kcal)	0.99 (0.04)	1.01 (0.03)	0.77
Dark green/orange vegetables (daily cups/1,000 kcal)	0.52 (0.03)	0.56 (0.02)	0.36
Total grain (daily ounces/1,000 kcal)	2.30 (0.07)	2.30 (0.05)	0.95
Whole grain (daily ounces/1,000 kcal)	0.81 (0.05)	0.87 (0.04)	0.37
Milk (daily cups/1,000 kcal)	0.70 (0.04)	0.68 (0.03)	0.62
Meat and beans (daily ounces/1,000 kcal)	0.34 (0.01)	0.37 (0.01)	0.02
Oils (daily grams per 1,000 kcal)	27.32 (0.50)	27.65 (0.36)	0.60
Saturated fat (percent of total kcal)	10.29 (0.19)	10.05 (0.14)	0.32
Sodium (daily grams per 1,000 kcal)	1.39 (0.02)	1.40 (0.02)	0.64
Calories from solid fat, alcohol, and added sugar (percent of total kcal)	17.44 (0.56)	16.49 (0.40)	0.18

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

Milk component includes all milk products

Cases and controls were classified into the three conventional HEI categories based on if their diet was "good" (score >80), "needs improvement" (51–80), or "poor" (<51). However, the "poor" category included fewer than 4% each of cases and controls while the "good" category included fewer than 13% each of cases and controls; hence to avoid having unstable estimates, the HEI score was categorized according to tertiles. Ovarian cancer risk estimates associated with HEI score tertiles and the HEI individual components are shown in Table 3. The risk estimate for the highest tertile of the HEI score when compared with the lowest tertile was below one; however, the confidence interval included the null value (OR = 0.90, 95% CI:0.55–1.47). Similarly, there were no other statistically significant associations between any of the individual food components and ovarian cancer risk.

Discussion

In this study, we found that adherence to the USDA Dietary Guidelines for Americans, as measured by the Healthy Eating Index, appeared to have limited value in preventing ovarian cancer. Overall, our study provided little support for a role of diet on ovarian cancer risk, which is consistent with current evidence linking nutritional factors and ovarian cancer prevention [5, 10, 39].

The HEI was revised in 2005 to increase emphasis on the quality of an individual's diet rather than quantity. Hence, components such as whole grains, whole fruit, and dark green and orange vegetables were added to the revised version of the index. Due to small numbers in the "poor" and "good" categories, we used tertile cutpoints for the HEI score instead of conventional thresholds. However, this is not unique to our study as several other studies that have investigated the association between HEI-2005 and cancer risk have also used quintiles and quartiles for the HEI in place of standard thresholds [18–22]. Prespecified cutoffs are also not emphasized in the development of the HEI-2005 [23]. Nonetheless, it is possible that we were unable to detect an association between the HEI and ovarian cancer risk because there was not enough range in the HEI values in this population. The HEI has been utilized in the past to estimate colorectal cancer risk [19, 20], breast cancer risk [18] endometrial cancer risk [17], major chronic disease risk [21, 22], and food avoidance due to oral health problems [33]. However, the HEI's potential to successfully predict these health conditions has not always been consistent. For instance, similar to our study, studies that evaluated major chronic disease (including cancer) risk in men and women [21, 22] and endometrial cancer risk [17] reported limited evidence for adherence to dietary guidelines in predicting disease risk. There was one study that investigated adherence to the Dietary Guidelines for Americans and incident ovarian cancers using data from the Iowa Women's Health Study [40]. In contrast to the HEI, their index included body mass index and physical activity. They reported increased ovarian cancer risk associated with higher dietary guidelines scores (meaning better compliance with the recommendations). However, when they evaluated their dietary guidelines index after excluding physical activity and BMI, the relationship disappeared and results were similar to ours.

In our study, when each of the 12 food components (total fruit, whole fruit, total vegetables, dark green and

Table 3 Association between the Healthy Eating Index (HEI) and its components and ovarian cancer risk

Variable in tertiles	Cases (*n*)	Controls (*n*)	OR1	95% CI	OR2	95% CI
HEI-2005 (score: 0–100)						
Tertile 1 (<67.39)	86	130	Ref		Ref	
Tertile 2 (67.39–74.50)	61	131	0.81	0.51–1.28	0.86	0.54–1.40
Tertile 3 (≥74.51)	58	129	0.84	0.52–1.34	0.90	0.55–1.47
p for trend			0.43		0.64	
Total fruit[a]						
Tertile 1 (<0.95)	86	130	Ref		Ref	
Tertile 2 (0.95–1.68)	62	127	0.91	0.57–1.43	0.93	0.58–1.49
Tertile 3 (≥1.69)	57	130	0.78	0.48–1.26	0.83	0.50–1.36
p for trend			0.32		0.46	
Whole fruit[a]						
Tertile 1 (<0.96)	87	126	Ref		Ref	
Tertile 2 (0.96–2.13)	68	127	0.97	0.61–1.52	0.95	0.59–1.53
Tertile 3 (≥2.14)	42	125	0.70	0.42–1.17	0.73	0.43–1.24
p for trend			0.16		0.23	
Total vegetables[a]						
Tertile 1 (<0.69)	69	130	Ref		Ref	
Tertile 2 (0.69–1.09)	72	129	1.05	0.67–1.66	1.08	0.68–1.73
Tertile 3 (≥1.10)	64	128	1.21	0.75–1.94	1.30	0.80–2.12
p for trend			0.43		0.28	
Dark green and orange vegetables[a]						
Tertile 1 (<0.29)	69	128	Ref		Ref	
Tertile 2 (0.29–0.61)	68	132	1.04	0.66–1.66	1.16	0.72–1.86
Tertile 3 (≥0.62)	68	127	1.12	0.70–1.79	1.28	0.78–2.08
p for trend			0.64		0.35	
Total grain[b]						
Tertile 1 (<1.87)	70	128	Ref		Ref	
Tertile 2 (1.87–2.56)	70	132	0.97	0.62–1.53	0.98	0.61–1.56
Tertile 3 (≥2.57)	65	130	0.93	0.59–1.49	0.92	0.57–1.49
p for trend			0.77		0.74	
Whole grain[b]						
Tertile 1 (<0.44)	69	127	Ref		Ref	
Tertile 2 (0.44–0.97)	79	131	1.36	0.86–2.14	1.31	0.82–2.10
Tertile 3 (≥0.98)	57	132	1.12	0.69–1.81	1.08	0.66–1.77
p for trend			0.80		0.93	
Milk[a]						
Tertile 1 (<0.34)	57	128	Ref		Ref	
Tertile 2 (0.34–0.81)	82	133	1.14	0.71–1.81	1.00	0.62–1.61
Tertile 3 (≥0.82)	66	129	1.19	0.74–1.92	1.11	0.68–1.82
p for trend			0.49		0.65	
Meat and beans[b]						
Tertile 1 (<0.29)	62	130	Ref		Ref	
Tertile 2 (0.29–0.40)	85	130	1.28	0.80–2.03	1.30	0.81–2.08
Tertile 3 (≥0.41)	58	130	0.64	0.39–1.06	0.65	0.39–1.09
p for trend			0.05		0.06	
Oils[c]						
Tertile 1 (<23.68)	57	130	Ref		Ref	
Tertile 2 (23.68–29.95)	65	130	0.97	0.59–1.57	0.95	0.58–1.57

Table 3 continued

Variable in tertiles	Cases (*n*)	Controls (*n*)	OR1	95% CI	OR2	95% CI
Tertile 3 (≥29.96)	83	130	1.29	0.81–2.08	1.25	0.77–2.04
p for trend			0.27		0.34	
Saturated fat[d]						
Tertile 1 (<8.51)	46	129	Ref		Ref	
Tertile 2 (8.51–10.84)	79	132	1.45	0.89–2.37	1.36	0.82–2.23
Tertile 3 (≥10.85)	80	129	1.45	0.87–2.40	1.29	0.77–2.17
p for trend			0.20		0.39	
Sodium[c]						
Tertile 1 (<1.26)	72	133	Ref		Ref	
Tertile 2 (1.26–1.46)	63	132	0.76	0.48–1.20	0.78	0.49–1.25
Tertile 3 (≥1.47)	70	125	0.68	0.43–1.10	0.66	0.40–1.07
p for trend			0.12		0.10	
SoFAAS[e]						
Tertile 1 (<12.87)	67	130	Ref		Ref	
Tertile 2 (12.87–19.09)	60	130	0.80	0.50–1.29	0.70	0.43–1.14
Tertile 3 (≥19.10)	78	130	1.22	0.76–1.94	1.16	0.71–1.89
p for trend			0.36		0.49	

OR1 adjusted for age (continuous), education (high school or less, college, graduate school), race (White, Black, Other, Hispanic), age at menarche (continuous), menopausal status (premenopausal, postmenopausal), parity (0–1, 2, 3–4), oral contraceptive use (ever, never), HRT use (never, unopposed estrogen only, any combined HRT), tubal ligation (no, yes), BMI (continuous), and total calories (continuous)

OR2 further adjusted for physical activity (METs for reported average hours per week of strenuous or moderate recreational activities), smoking status (never, past, current), and pack years smoked (continuous)

[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] Calculated as a percent of total kcal

[e] SoFAAS: total calories from solid fat, alcoholic beverages, and added sugar expressed as percent of total kcal

orange vegetables, total grain, whole grain, milk, meat and beans, oils, saturated fat, sodium, and total calories from solid fat, alcoholic beverages, and added sugar) making up the HEI was individually analyzed, no major associations emerged. Our findings are consistent with other studies [5] and with the conclusion of the 2007 WCRF/AIRC Report [10], which found the evidence linking diet and ovarian cancer to be limited.

Certain limitations of this study should be noted. Some institutional barriers precluded the concurrent recruitment and data collection in the ovarian case group and the controls in the EDGE Study, as initially planned. However, we conducted a secular trend analysis for cases and controls to assess possible changes in dietary intake over time. There was no significant difference in age-adjusted mean values for the HEI score, total vegetable, total fruit, or percentage of saturated fat intake between two time periods for either cases or controls.

As in any case–control study, the issue of recall bias cannot be ignored especially for a disease such as ovarian cancer. Ovarian cancer is typically diagnosed in advanced stages, and cases tend to be very sick when they are diagnosed, which could impair their ability to recall their dietary intake prior to diagnosis. However, consistency of our findings with current literature on the topic provides some reassurance. Another concern is the low response rates. Participation rates around 50% in population-based studies are not unusual today, particularly among controls [41]. To evaluate possible selection bias, we compared the characteristics of women consenting to participate in the study to all women diagnosed with epithelial ovarian cancer using New Jersey State Cancer Registry data in the same counties during a similar time period [42]. Race and ethnic distribution was similar, while the cases consenting tended to be slightly younger with a median age of 56 years at diagnosis, compared with a median age of 61 years at diagnosis for the total population of cases. The distribution by histology, stage, and grade was generally similar. 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 is similar to that reported in other studies. This provides some reassurance that any potential selection bias may be minimal.

In conclusion, we did not observe any evidence that following the Dietary Guidelines for Americans helps in reducing ovarian cancer risk. However, this has not been evaluated in large cohort studies, which may provide more definite evidence regarding their possible role on ovarian cancer prevention.

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Appendix

See Table 4.

Table 4 Healthy Eating Index 2005—components and standards for scoring [23]

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

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