Published in final edited form as:
Nutr Cancer. 2013 ; 65(6): 820–826. doi:10.1080/01635581.2013.804939.

Are diet quality scores after breast cancer diagnosis associated with improved breast cancer survival?

Monika A. Izano[1,2], **Teresa T. Fung**[1,3], **Stephanie S Chiuve**[4,5], **Frank B. Hu**[1,2], and **Michelle D. Holmes**[1,2]

[1]The Channing Division of Network Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA

[2]Department of Epidemiology, Harvard School of Public Health, Boston MA

[3]Department of Nutrition, Simmons College, Boston, MA

[4]Department of Nutrition, Harvard School of Public Health, Boston MA

[5]Division of Preventive Medicine, Department of Medicine, Brigham and Women's Hospital and Harvard Medical School, Boston, MA

Abstract

Background—Previous studies have found that diets rich in fruits and vegetables are associated with reduced breast cancer mortality. However, these eating patterns do not necessarily reflect overall diet quality. The association of breast cancer mortality with a priori defined dietary scores, which are based on recommended dietary guidelines and reflect diet quality, has not been evaluated. We hypothesized that diet quality indices based on recommended guidelines are associated with decreased risk of breast cancer and non-breast cancer mortality in breast cancer survivors.

Methods—We examined the association between the Dietary Approaches to Stop Hypertension (DASH) score, and the Alternative Healthy Eating Index (AHEI)-2010, and the risk of breast cancer mortality and total mortality among women from the Nurses' Health Study diagnosed with breast cancer.

Results—Adherence to DASH-style and AHEI-2010 diets were associated with reduced risk of non-breast cancer mortality (comparing the fifth quintile with the first quintile RR = 0.72, 95% CI: 0.53–0.99, p-trend = 0.03 for DASH, and RR = 0.57, 95% CI: 0.42–0.77, p-trend <0.0001 for AHEI-2010). Diet scores were not significantly associated with breast cancer mortality.

Conclusions—Our findings suggest that adherence to a higher quality diet after breast cancer diagnosis does not considerably change the risk of breast cancer death and recurrence. However, healthy dietary choices after breast cancer were associated with reduced risk of non-breast cancer mortality in women with breast cancer.

INTRODUCTION

A number of studies have evaluated the a possible link between diet and breast cancer survival, the majority focusing on specific nutrients [1–4] such as fat intake [3, 5–7], and

Corresponding author: Dr. Holmes, 617-525-2279, michelle.holmes@channing.harvard.edu.

Conflict of Interests

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; and preparation, review, or approval of the manuscript. The authors have no further financial relationship with the funders. The authors have full control of all primary data and the Journal may review the data if requested.

dietary patterns [8, 9]. Fruit and vegetable intake [10], as well as whole grain intake [11] have been shown to be associated with lower risk of mortality after breast cancer, whereas higher consumption of animal fat has been shown to increase this risk [5, 6, 12]. Studies that evaluated the influence of dietary patterns on breast cancer survival have not established an association [8, 9]. However, single nutrient intake and dietary patterns defined by statistical approaches may not necessarily reflect diet quality. Overall diet quality is reflected by *a priori* defined dietary scores that are constructed based on recommended dietary guidelines. The association of diet quality scores with breast cancer survival has not been evaluated. Therefore, in this study we investigate the association between diet quality scores after a diagnosis of breast cancer and the risk of breast cancer mortality and overall mortality among breast cancer survivors.

The Dietary Approaches to Stop Hypertension (DASH) which emphasizes plant proteins, fruits and vegetables, moderate amounts of low-fat dairy products, and low amounts of sweets and sodium, is a healthy eating pattern recommended for the general public by the United States Department of Agriculture [13]. Adherence to a DASH style diet has been associated with reduced risk of colorectal cancer [14], and reduced risk of estrogen receptor-negative (ER−) breast cancer in postmenopausal women [15]. The Alternative Healthy Eating Index (AHEI), another diet quality index, was created in 2002, and emphasizes dietary patterns that have been shown to reduce the risk of chronic disease. One study reported an inverse association between a high score on the vegetable component of AHEI and the risk of ER− breast cancer in postmenopausal women [16]. This score was recently updated to include additional dietary factors that have since been shown to predict chronic disease, and is now referred to as AHEI-2010 [17]. The association between the DASH and AHEI-2010 scores and breast cancer survival has not been evaluated. As the association may vary by estrogen receptor status, we conducted analyses separately for estrogen receptor-positive (ER+) and negative (ER−) tumors.

METHODS

Study Population

The Nurses' Health Study (NHS) is a cohort study established in 1976, when 121,700 female nurses from 11 US states, then aged 30 to 55 years, responded to a questionnaire regarding medical and lifestyle factors. Since then, follow-up questionnaires have been sent biannually. Beginning in 1980 participants completed a 61-item food frequency questionnaire (FFQ) {Willett, 1985 #62}. Dietary assessments were expanded to 116 items in 1984, and were administered in 1984, 1986, 1990, 1994, 1998, and 2002.

The present analysis includes women diagnosed with stages I–III breast cancer between 1980 and 2003, with diet data beginning in 1984 (n=7,717). Women with a missing stage (n=2,424) or who were stage IV at diagnosis (n=127), who had died or whose cancer had recurred within 1 year of primary diagnoses (n=392), who had missing diet information at least 12 months after diagnosis (n=671), were excluded from analyses. After these exclusions, 4,103 participants were available for this analysis.

Assessment of Dietary Intake

Diet was first assessed in 1980, 1984, 1986, and updated every 4 years thereafter until 2002. Data from FFQs were used in the derivation of AHEI-2010, and DASH scores. Previous validation studies have reported strong correlations between energy-adjusted nutrients assessed by the FFQ and food records completed over the previous year [18]. The computation of these scores has been described elsewhere [19, 17]. Briefly, to compute the DASH score, women were classified into quintiles of intake for each of 8 components. For fruits, vegetables, nuts and legumes, low-fat dairy products, and whole grains, the lowest quintile was given a score of 1, and highest quintile was given a score of 5. For components such as sweets, red and processed meat, and sodium, for which a low intake is recommended, the scoring was reversed. When individual component scores were summed up, women were assigned a DASH score, reflecting adherence to a DASH diet, and ranging from 8 (nonadherence) to 40 (perfect adherence) [19].

The AHEI-2010 score is based on 11 components, each given a minimal score of 0 and a maximal score of 10, with intermediate values scored proportionally. For components such as vegetables, fruits, nuts and legumes, whole grains, *trans* fats, long-chain (n-3) fats (EPA + DHA), and polyunsaturated fats, the recommended daily intake was assigned a score of 10; no intake was assigned the minimal score of 0. High intakes of components for which a low intake is recommended, such as sugar-sweetened beverages and fruit juice, red or processed meat, sodium, and alcohol, were scored lower than recommended intakes. Component scores were then summed up to give the total AHEI-2010 score, ranging from 0 (nonadherence) to 110 (perfect adherence) [17].

For each participant, diet was first characterized using the questionnaire that most closely followed at least 12 months after diagnosis and subsequently updated until the end of the follow-up. Since the last dietary assessment questionnaire was sent out in June 2002 and returned between June 2002 and May 2004, this analysis includes women diagnosed with breast cancer between June 1980 and May 2003.

Endpoint Ascertainment

Participants were followed until death or February 2010, whichever occurred first. Breast cancer death was the primary endpoint. Deaths were reported by family members, the postal service, or searches in the National Death Index for questionnaire non-responders [20]. Cause of death was ascertained by physicians' review of death certificates and medical records when needed. The ascertainment of the cause of death in this cohort is estimated to be 98% [20].

Distant breast cancer recurrence and non-breast cancer mortality were secondary endpoints. Women reported recurrence on supplemental biennial questionnaires. In addition, women who died from breast cancer were considered to have recurred 2 years prior to their death, the median survival time for stage IV breast cancer. We assumed breast cancer had recurred if a woman diagnosed with breast cancer reported a second cancer to a common site of recurrence (liver, brain, bone, or lung). Medical records of women who reported a second cancer to the lung were reviewed to distinguish between primary lung cancer and breast cancer metastases [21].

Covariates

Body mass index (5-categories), weight change, menopausal status, hormone therapy use, age at first birth, parity, and oral contraceptive use (yes/no) were included, as these factors have been previously shown to be associated with breast cancer survival in the NHS cohort [22, 3, 23]. Additionally we adjusted for breast cancer characteristics including year of diagnosis, disease stage (I, II, III), self-reported radiation (yes/no), chemotherapy (yes/no), and hormonal treatment (yes/no). Smoking was also included due to its association with total mortality. Physical activity measured in total metabolic equivalent task hours per week was first assessed in 1986, and updated in 1988, 1992, 1996, 1998, 2000, and 2004. To avoid assessment during active treatment, only measurements taken at least 2 years after diagnosis were considered. Energy intake (5 categories), multivitamin use (yes/no), alcohol consumption (5 categories), and macronutrient intake were first assessed using the questionnaire that most closely followed at least 12 months after breast cancer diagnosis. All other covariates were taken from the questionnaire preceding the diagnosis.

Statistical analyses

To evaluate the long and short-term effects of diet on breast cancer survival, analyses were conducted using diet assessed at baseline, simple-updated, and cumulatively averaged and updated. Baseline diet was ascertained using the first FFQ, at least 12 months following breast cancer diagnoses. This was done in order to allow the completion of active treatment, which may affect diet. In simple-updated analyses, each dietary assessment was applied to the subsequent time period. For example, the score from 1984 was used to predict breast cancer survival from 1984 to 1986 and the score from 1986 was used to predict breast cancer survival from 1986 to 2000. In order to reduce random within-person variation and best represent the long-term effects of dietary intake, cumulative averages of the diet scores from repeated FFQs were computed. As described elsewhere [24], in these analyses the average score from 1980 and 1984 was used to predict breast cancer survival from 1984 to 1986, the average score from1980, 1984 and 1986 were used to predict breast cancer survival from 1986 to 2000 and so forth for the duration of the follow-up. Women were categorized into quintiles of dietary scores. 2-tailed P values for linear trend tests across quintiles were computed by modeling the median value of each category as a continuous variable.

We used Cox proportional hazards models to assess the association between quintiles of dietary scores and the outcomes of interest. All Cox models were tested for proportionality of hazards by testing the statistical significance of time-varying covariates, created as interactions between each predictor and the log of the event time [25]. Death from breast cancer was the primary endpoint. Secondary analyses considered breast cancer recurrence, non-breast cancer death, and total mortality. For each participant, breast cancer diagnosis marked the beginning of the follow-up. Person-months were accumulated until the analysis endpoint, or February 2010, whichever occurred first.

Because time-since-diagnosis (TSD) is a strong predictor of breast-cancer survival, all models were stratified by TSD. Simple models were additionally adjusted for age. Multivariate models were adjusted for the covariates listed in the previous section. In addition, we conducted analyses stratified by the estrogen receptor status of the tumor. Statistical analyses were carried out using SAS version 9.2 (SAS Institute, Inc.). P values of <0.05 were considered significant.

RESULTS

We identified 4103 participants with invasive stage I–III breast cancer diagnosed between 1980 and 2003. Median length of follow-up was 112 months, and maximum length of follow-up was 277 months. Participants were followed through 2010. During this time 981 women died. In addition to the 453 breast cancer deaths, there were 38 breast cancer recurrences. Of the 528 non-breast cancer related deaths, 120 (22.7%) were from cardiovascular disease, 42 (8.0%) from primary lung cancer, 139 (26.3%) were from other cancers, and 227 (43.0%) were from other causes.

Age-standardized characteristics according to quintiles of dietary scores are shown in Table 1. Women with higher DASH and AHEI-2010 scores tended to have lower BMI, higher levels of physical activity, consume less alcohol, were less likely to be smokers, suggesting that adherence to these diets is predictive of a healthier lifestyle. Additionally, women with higher DASH scores had higher carbohydrate and protein intake, but lower fat intake than women with lower DASH scores. On the other hand, women with higher AHEI-2010 scores had lower protein, carbohydrate, and fat intake than women with lower AHEI-2010 scores.

We computed the relative risk and the 95% confidence intervals for breast cancer death using cumulatively averaged and updated dietary scores, and we observed no association with breast cancer mortality (Table 2) or recurrence (not shown) in multivariate models. Analyses using baseline and simple updated diet assessments gave similar results (not shown).

In simple models stratified by time since diagnosis and adjusted for age at diagnosis and energy intake, higher cumulatively average and updated DASH and AHEI-2010 scores were associated with a decreased risk of death from causes other than breast cancer (Table 3). The associations were slightly attenuated but remained statistically significant after adjustment for potential confounders (comparing the fifth quintile with the first quintile RR = 0.72, 95% CI: 0.53–0.99, p-trend = 0.03 for DASH, and RR = 0.57, 95% CI: 0.42–0.77, p-trend <0.0001 for AHEI-2010). Lastly, we conducted analyses of breast cancer death stratified by the ER status of the tumor and found no evidence of effect modification (Table 4).

DISCUSSION

We found no association between dietary scores and breast cancer survival. Closer adherence to DASH style and AHEI-2010 diets were, however, associated with significantly lower risk of non-breast cancer mortality.

Recently, the Nurses' Health Study reported a lack of association between post-diagnosis diet quality scores, such as the Alternate Healthy Eating Index (AHEI), Diet Quality Index-Revised (DQIR), Recommended Food Score (RFS), the alternate Mediterranean Diet Score (aMed), and breast cancer specific, non-breast cancer, and total mortality [26]. The scores evaluated did not include DASH and AHEI-2010 scores. In that prior analysis, diet scores were not updated during the follow-up.

The Women's Intervention Nutrition Study (WINS) trial found that a low-fat dietary intervention lead to a decreased risk of breast cancer recurrence, but had no effect on overall survival. However, after a median follow-up of 60 months, authors reported a statistically significant 6-pound lower mean body weight in the intervention group, even though the intervention and control arms of the trial were designed to be isocaloric [27]. In a follow-up analysis investigators proposed that even modest weight loss can improve insulin sensitivity and subsequently affect the action of tumor promoters such as IGF-1 [28]. The question whether the reduction in the improved relapse-free survival was the direct effect of a low-fat diet or mediated by weight loss was not answered by the trial. Women in the intervention group of the Women's Healthy Eating and Living (WHEL) trial, which targeted both reduced fat intake as well as increased fruits, vegetables and fibers intake, did not lose weight. Investigators reported no association between diet and survival in this trial [29]. Conducting randomized control trials of lifestyle factors can be difficult. Subjects randomized to the control arm may take up the intervention, while subjects in the intervention group may not comply [30]. Furthermore, since exposures during childhood and early adulthood appear particularly important for breast cancer, trials shorter in duration than prospective longitudinal studies may miss this critical period [30]. Faced with such challenges, information from observational studies of the impact of lifestyle factors on survival of women with breast cancer beyond medical treatment remains valuable.

The current analysis has several strengths over earlier work. Our large sample size and approximately 30 years of follow-up provided sufficient power to examine breast-cancer mortality, and conduct stratified analyses. Repeated dietary assessment allowed us to take into account dietary changes during the follow-up period. Multivariate analyses were adjusted for many factors known to affect survival after breast cancer, including weight change and physical activity, which have recently been found to affect overall and relapse-free survival [19, 31].

Limitations include self-reported diet, physical activity, treatment and recurrence, which were not confirmed by record review. The accuracy of self-reported diet was improved by frequent updating [24]. Cause of death may have been misclassified, despite physician's review of medical records. Further, the construction of the DASH score involved some arbitrary decision about the type and number of foods included, and the number of points assigned to various amounts of intake [32]. Lastly, women whose disease recurred or who died less than a year after breast cancer diagnosis were excluded from analyses. It is thus likely, that our findings are not generalizable to women with the most severe disease.

Our findings are consistent with earlier reports that suggested that overall diet does not affect breast cancer survival or recurrence. Adherence to healthy diet styles however, are associated with decreased risk of death from other causes and is therefore important to women diagnosed with breast cancer.

Acknowledgments

This work was supported by National Institutes of Health grants CA87969, HL60712, CA95589, and CA58895. We wish to thank the participants and staff of the Nurses' Health Study, for their valuable contributions as well as the following state cancer registries for their help: AL, AZ, AR, CA, CO, CT, DE, FL, GA, ID, IL, IN, IA, KY, LA, ME, MD, MA, MI, NE, NH, NJ, NY, NC, ND, OH, OK, OR, PA, RI, SC, TN, TX, VA, WA, WY.

References

1. Goodwin PJ, Ennis M, Pritchard KI, Koo J, Trudeau ME, Hood N. Diet and breast cancer: evidence that extremes in diet are associated with poor survival. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 2003; 21(13):2500–2507.10.1200/JCO.2003.06.121 [PubMed: 12829669]
2. Sellers TA, Alberts SR, Vierkant RA, Grabrick DM, Cerhan JR, Vachon CM, Olson JE, Kushi LH, Potter JD. High-folate diets and breast cancer survival in a prospective cohort study. Nutrition and cancer. 2002; 44(2):139–144.10.1207/S15327914NC4402_03 [PubMed: 12734059]
3. Holmes MD, Hunter DJ, Colditz GA, Stampfer MJ, Hankinson SE, Speizer FE, Rosner B, Willett WC. Association of dietary intake of fat and fatty acids with risk of breast cancer. JAMA : the journal of the American Medical Association. 1999; 281(10):914–920. [PubMed: 10078488]
4. Melchior MB, Fink-Gremmels J, Gaastra W. Comparative assessment of the antimicrobial susceptibility of Staphylococcus aureus isolates from bovine mastitis in biofilm versus planktonic culture. Journal of veterinary medicine B, Infectious diseases and veterinary public health. 2006; 53(7):326–332.10.1111/j.1439-0450.2006.00962.x
5. Jain M, Miller AB, To T. Premorbid diet and the prognosis of women with breast cancer. Journal of the National Cancer Institute. 1994; 86(18):1390–1397. [PubMed: 8072032]
6. Holm LE, Nordevang E, Hjalmar ML, Lidbrink E, Callmer E, Nilsson B. Treatment failure and dietary habits in women with breast cancer. Journal of the National Cancer Institute. 1993; 85(1): 32–36. [PubMed: 8416253]
7. Nomura AM, Marchand LL, Kolonel LN, Hankin JH. The effect of dietary fat on breast cancer survival among Caucasian and japanese women in Hawaii. Breast cancer research and treatment. 1991; 18(Suppl 1):S135–141. [PubMed: 1873551]
8. Kwan ML, Weltzien E, Kushi LH, Castillo A, Slattery ML, Caan BJ. Dietary patterns and breast cancer recurrence and survival among women with early-stage breast cancer. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 2009; 27(6):919–926.10.1200/JCO.2008.19.4035 [PubMed: 19114692]

9. Kroenke CH, Fung TT, Hu FB, Holmes MD. Dietary patterns and survival after breast cancer diagnosis. Journal of clinical oncology : official journal of the American Society of Clinical Oncology. 2005; 23(36):9295–9303.10.1200/JCO.2005.02.0198 [PubMed: 16361628]

10. Ingram D. Diet and subsequent survival in women with breast cancer. British journal of cancer. 1994; 69(3):592–595. [PubMed: 8123493]

11. Saxe GA, Rock CL, Wicha MS, Schottenfeld D. Diet and risk for breast cancer recurrence and survival. Breast cancer research and treatment. 1999; 53(3):241–253. [PubMed: 10369070]

12. Hebert JR, Hurley TG, Ma Y. The effect of dietary exposures on recurrence and mortality in early stage breast cancer. Breast cancer research and treatment. 1998; 51(1):17–28. [PubMed: 9877026]

13. United States. Dept. of Health and Human Services. United States. Dept. of Agriculture. United States. Dietary Guidelines Advisory Committee. Dietary guidelines for Americans, 2005. 6. G.P.O.: Washington, D.C; 2005. HHS publication ; no HHS-ODPHP-2005-01-DGA-A

14. Dixon LB, Subar AF, Peters U, Weissfeld JL, Bresalier RS, Risch A, Schatzkin A, Hayes RB. Adherence to the USDA Food Guide, DASH Eating Plan, and Mediterranean dietary pattern reduces risk of colorectal adenoma. J Nutr. 2007; 137(11):2443–2450. [PubMed: 17951483]

15. Fung TT, Hu FB, Hankinson SE, Willett WC, Holmes MD. Low-carbohydrate diets, dietary approaches to stop hypertension-style diets, and the risk of postmenopausal breast cancer. Am J Epidemiol. 174:652–660. [PubMed: 21832271]

16. Fung TT, Hu FB, McCullough ML, Newby PK, Willett WC, Holmes MD. Diet quality is associated with the risk of estrogen receptor-negative breast cancer in postmenopausal women. J Nutr. 2006; 136(2):466–472. [PubMed: 16424129]

17. Chiuve SEFTT, Rimm EB, Hu FB, McCullough ML, Wang M, Stampfer MJ, Willett WC. Alternative Dietary Indices Both Strongly Predict Risk of Chronic Disease. J Nutr. 2012; (142): 1009–1018. [PubMed: 22513989]

18. Willett, W. Monographs in epidemiology and biostatistics. 2. Vol. 30. Oxford University Press; New York: 1998. Nutritional epidemiology.

19. 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. Archives of internal medicine. 2008; 168(7):713–720.10.1001/archinte.168.7.713 [PubMed: 18413553]

20. Stampfer MJ, Willett WC, Speizer FE, Dysert DC, Lipnick R, Rosner B, Hennekens CH. Test of the National Death Index. Am J Epidemiol. 1984; 119(5):837–839. [PubMed: 6720679]

21. Holmes MD, Murin S, Chen WY, Kroenke CH, Spiegelman D, Colditz GA. Smoking and survival after breast cancer diagnosis. Int J Cancer. 2007; 120(12):2672–2677. [PubMed: 17278091]

22. Holmes MD, Chen WY, Feskanich D, Kroenke CH, Colditz GA. Physical activity and survival after breast cancer diagnosis. Jama. 2005; 293(20):2479–2486. [PubMed: 15914748]

23. Kroenke CH, Chen WY, Rosner B, Holmes MD. Weight, weight gain, and survival after breast cancer diagnosis. J Clin Oncol. 2005; 23(7):1370–1378. [PubMed: 15684320]

24. Hu FB, Stampfer MJ, Rimm E, Ascherio A, Rosner BA, Spiegelman D, Willett WC. Dietary fat and coronary heart disease: a comparison of approaches for adjusting for total energy intake and modeling repeated dietary measurements. Am J Epidemiol. 1999; 149(6):531–540. [PubMed: 10084242]

25. Prentice RL, Kalbfleisch JD. Hazard rate models with covariates. Biometrics. 1979; 35(1):25–39. [PubMed: 497336]

26. Kim EH, Willett WC, Fung T, Rosner B, Holmes MD. Diet quality indices and postmenopausal breast cancer survival. Nutr Cancer. 63:381–388. [PubMed: 21462090]

27. Chlebowski RT, Blackburn GL, Thomson CA, Nixon DW, Shapiro A, Hoy MK, Goodman MT, Giuliano AE, Karanja N, McAndrew P, Hudis C, Butler J, Merkel D, Kristal A, Caan B, Michaelson R, Vinciguerra V, Del Prete S, Winkler M, Hall R, Simon M, Winters BL, Elashoff RM. Dietary fat reduction and breast cancer outcome: interim efficacy results from the Women's Intervention Nutrition Study. J Natl Cancer Inst. 2006; 98(24):1767–1776. [PubMed: 17179478]

28. Blackburn GL, Wang KA. Dietary fat reduction and breast cancer outcome: results from the Women's Intervention Nutrition Study (WINS). Am J Clin Nutr. 2007; 86(3):s878–881. [PubMed: 18265482]

29. Pierce JP, Natarajan L, Caan BJ, Parker BA, Greenberg ER, Flatt SW, Rock CL, Kealey S, Al-Delaimy WK, Bardwell WA, Carlson RW, Emond JA, Faerber S, Gold EB, Hajek RA, Hollenbach K, Jones LA, Karanja N, Madlensky L, Marshall J, Newman VA, Ritenbaugh C, Thomson CA, Wasserman L, Stefanick ML. Influence of a diet very high in vegetables, fruit, and fiber and low in fat on prognosis following treatment for breast cancer: the Women's Healthy Eating and Living (WHEL) randomized trial. Jama. 2007; 298(3):289–298. [PubMed: 17635889]

30. Michels KB, Willett WC. The Women's Health Initiative Randomized Controlled Dietary Modification Trial: a post-mortem. Breast cancer research and treatment. 2009; 114(1):1–6.10.1007/s10549-008-9972-x [PubMed: 18373274]

31. Halton TL, Liu S, Manson JE, Hu FB. Low-carbohydrate-diet score and risk of type 2 diabetes in women. Am J Clin Nutr. 2008; 87(2):339–346. [PubMed: 18258623]

32. Fung TT, Hu FB, Wu K, Chiuve SE, Fuchs CS, Giovannucci E. The Mediterranean and Dietary Approaches to Stop Hypertension (DASH) diets and colorectal cancer. The American journal of clinical nutrition. 2010; 92(6):1429–1435.10.3945/ajcn.2010.29242 [PubMed: 21097651]

Table 1

Age-Standardized Levels of Covariates, According to Quintiles of Baseline Diet Scores, Among US Female Nurses Diagnosed with Breast Cancer in 1980–2003 (N= 4,103)

	Quintiles of Diet Scores			
	DASH		AHEI-2010	
	Q1	Q5	Q1	Q5
Mean (SD)				
Age at diagnosis	60.2 (8.3)	60.4 (8.2)	60.4 (8.6)	60.4 (8.3)
Age at first birth (parous women), years	24.4 (7.8)	25.1 (7.9)	24.9 (9.0)	25.1 (25.3)
Parity (parous women), no.	3.1 (1.6)	3.1 (1.7)	3.1 (1.7)	3.1 (0.5)
BMI at diagnosis, kg/m^2	26.6 (5.1)	25.3 (4.6)	26.9 (5.5)	24.9 (4.1)
Physical activity, MET-hours/week	10.5 (13.9)	21.0 (24.6)	12.1 (16.7)	22.2 (26.4)
Calories, mean (kcal)	1663.4 (521.3)	1839.4 (496.9)	1881.5 (519.2)	1645.5 (520.7)
Alcohol (g)	6.4 (12.6)	5.2 (9.4)	7.3 (15.3)	5.5 (6.8)
Protein	69.5 (22.5)	84.3 (25.3)	79.4 (24.8)	75.5 (25.3)
Carbohydrate (g)	203.4 (75.0)	260.9 (76.3)	241.4 (77.9)	222.1 (85.1)
Total fat (g)	61.6 (23.2)	53.5 (21.7)	64.7 (22.8)	52.6 (21.8)
Percentage				
Ever used oral contraceptives	45%	46%	44%	46%
Postmenopausal hormones *	17%	20%	20%	20%
Current Smoker	25%	8%	20%	10%
Postmenopausal at diagnosis	77%	78%	77%	77%
Estrogen receptor positive	79%	81%	79%	81%
Stage I disease	57%	56%	57%	58%
Stage II disease	34%	33%	32%	31%
Stage III disease	10%	11%	11%	11%
Radiation treatment	45%	42%	45%	42%
Chemotherapy	36%	32%	36%	33%
Hormonal Treatment	62%	59%	62%	59%

Abbreviations: MET, metabolic equivalent task; Q, Quintile

* Use at the time of diagnosis

Table 2

Relative Risk (RR) and 95% CI of Cumulatively Averaged and Updated Quintiles of Diet Scores for Breast Cancer Mortality

	Quintiles of Diet Scores					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**p-trend**
DASH (Cases, Person-months)	**62 (125,470)**	**90 (156,796)**	**109 (194,440)**	**78 (149,433)**	**114 (175,794)**	
Simple Model	1.00	0.92 (0.67–1.26)	0.90 (0.66–1.24)	1.09 (0.80–1.48)	1.03 (0.76–1.41)	0.47
Covariate Adjusted	1.00	0.73 (0.52–1.02)	0.78 (0.56–1.09)	0.98 (0.71–1.35)	0.85 (0.61–1.19)	0.93
AHEI-2010 (Cases, Person-months)	**70 (145,759)**	**85 (153,602)**	**85 (169,973)**	**97 (164,473)**	**116 (168,126)**	
Simple Model	1.00	1.06 (0.78–1.45)	0.95 (0.70–1.30)	1.01 (0.74–1.37)	1.03 (0.76–1.40)	0.95
Covariate Adjusted	1.00	1.15 (0.83–1.58)	0.95 (0.68–1.32)	1.09 (0.79–1.52)	1.07 (0.77–1.49)	0.82

Simple Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years) and quintiles of energy intake

Adjusted Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years), quintiles of energy intake, body mass index, body mass index change, age at first birth and parity, oral contraceptive use, menopausal status and HRT use, smoking, stage of disease, radiation treatment, chemotherapy and hormonal treatment, and physical activity

Table 3

Relative Risk (RR) and 95% CI of Cumulatively Averaged and Updated Quintiles of Diet Scores for Non-Breast Cancer Mortality

	Quintiles of Diet Scores					
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**p-trend**
DASH (Cases, Person-months)	**102 (123,227)**	**110 (158,579)**	**122 (198,428)**	**89 (152,792)**	**105 (182,642)**	
Simple Model	1.00	0.90 (0.68–1.21)	0.70 (0.52–0.94)	0.72 (0.54–0.96)	0.59 (0.44–0.79)	0.0001
Covariate Adjusted	1.00	0.93 (0.69–1.26)	0.79 (0.58–1.07)	0.84 (0.62–1.13)	0.72 (0.53–0.99)	0.03
AHEI-2010 (Cases, Person-months)	**120 (142,079)**	**106 (156,644)**	**108 (171,307)**	**110 (168,342)**	**84 (177,296)**	
Simple Model	1.00	0.81 (0.62–1.06)	0.67 (0.51–0.88)	0.49 (0.37–0.66)	0.48 (0.36–0.64)	<.0001
Covariate Adjusted	1.00	0.86 (0.65–1.13)	0.73 (0.55–0.96)	0.54 (0.40–0.73)	0.57 (0.42–0.77)	<.0001

Simple Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years) and quintiles of energy intake

Adjusted Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years), quintiles of energy intake, body mass index, body mass index change, age at first birth and parity, oral contraceptive use, menopausal status and HRT use, smoking, stage of disease, radiation treatment, chemotherapy and hormonal treatment, and physical activity

Table 4

Covariate-Adjusted Relative Risk (RR) and 95% CI of Cumulative Averaged and Updated Quintiles of Diet Scores for Breast Cancer Mortality by ER Status

	Quintiles of Diet Scores						
	Q1	**Q2**	**Q3**	**Q4**	**Q5**	**p-trend**	**p-interaction**
DASH							
ER+, Cases (Person-months)	48 (83,886)	69 (110,913)	63 (117,388)	77 (123,521)	75 (119,847)		
RR (95% CI)	1	0.83 (0.56–1.25)	0.89 (0.59–1.35)	1.03 (0.69–1.54)	0.87 (0.58–1.32)	0.96	
ER−, Cases (Person-months)	15 (30,658)	9 (29,530)	13 (25,719)	20 (27,659)	12 (31,363)		**0.82**
RR (95% CI)	1	0.85 (0.30–2.40)	1.46 (0.49–4.39)	1.33 (0.50–3.50)	0.65 (0.22–1.93)	0.64	
AHEI-2010							
ER+, Cases (Person-months)	52 (92,459)	68 (106,819)	67 (115,135)	73 (118,876)	72 (122,266)		
RR (95% CI)	1	0.87 (0.34–2.23)	0.46 (0.17–1.29)	0.79 (0.28–2.21)	0.89 (0.30–2.66)	0.75	
ER−, Cases (Person-months)	16 (28,325)	16 (29,939)	11 (30,161)	11 (28,205)	15 (28,299)		**0.64**
RR (95% CI)	1	0.87 (0.34–2.23)	0.46 (0.17–1.29)	0.79 (0.28–2.21)	0.89 (0.30–2.66)	0.98	

Simple Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years) and quintiles of energy intake

Adjusted Models: Stratified by time since diagnosis (months), adjusted for age at diagnosis (years), quintiles of energy intake, body mass index, age at first birth and parity, oral contraceptive use, menopausal status and HRT use, smoking, stage of disease, radiation treatment, chemotherapy and hormonal treatment, and physical activity