Dietary patterns and breast cancer risk: a systematic review and meta-analysis1–3

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ABSTRACT
Background: Dietary patterns, which represent whole-diet and possible food and nutrient interactions, have been linked to the risk of various cancers. However, the associations of these dietary patterns with breast cancer remain unclear.
Objective: We critically appraised the literature and conducted meta-analyses to pool the results of studies to clarify the relation between dietary patterns and breast cancer risk.
Design: MEDLINE and EMBASE were searched for relevant articles that identified common dietary patterns published up to November 2009. Multivariable-adjusted odds ratios (ORs) comparing highest and lowest categories of dietary pattern scores and multivariable-adjusted ORs for a 20th-percentile increase in dietary pattern scores were combined by using random-effects meta-analyses.
Results: Case-control and cohort studies were retrieved that identified prudent/healthy (n = 18), Western/unhealthy (n = 17), and drinker (n = 4) dietary patterns. There was evidence of a decrease in the risk of breast cancer in the highest compared with the lowest categories of prudent/healthy dietary patterns (OR = 0.89; 95% CI: 0.82, 0.99; P = 0.02) in all studies and in pooled cohort studies alone. An increase in the risk of breast cancer was shown for the highest compared with the lowest categories of a drinker dietary pattern (OR = 1.21; 95% CI: 1.04, 1.41; P = 0.01). There was no evidence of a difference in the risk of breast cancer between the highest and lowest categories of Western/unhealthy dietary patterns (OR = 1.09; 95% CI: 0.98, 1.22; P = 0.12).
Conclusion: The results of this systematic review and meta-analysis indicate that some dietary patterns may be associated with breast cancer risk. Am J Clin Nutr 2010;91:1294–302.

INTRODUCTION
Breast cancer is one of the most common cancers among women in the United Kingdom and incidence continues to rise (1). Multiple risk factors for breast cancer such as family history, obesity, lactation, adult attained height, menstrual history, and reproductive history are well established but are generally difficult to modify (2–5, 16).
A substantial amount of research (6–15) has explored the influence of diet, a modifiable risk factor on breast cancer risk, and it is estimated that approximately one-third of cases could be prevented by dietary modification, whereas 20% can be attributable to consuming ≥2 alcoholic drinks/d. This highlights the theoretical scope for the prevention of this disease through behavior modification. The majority of research has focused on the effect of individual foods and nutrients, but according to the World Cancer Research Fund (WCRF) report (16), convincing evidence has only been shown for high alcohol consumption.
From an epidemiologic perspective, foods and nutrients are never eaten in isolation and their effects are likely to interact (8). This has led to the adoption of a more holistic approach to diet that is implemented by the identification of patterns of dietary intake that aim to represent the complex interaction between foods and nutrients and avoid confounding effects, which may mask true associations.
Many studies (17–21) used factor analysis or principal component analysis to derive dietary patterns. These statistical techniques aggregate variables into factors that represent the broad eating patterns of the population being studied. With the use of this approach, associations were observed between dietary patterns and the risk of renal, gastric, and colorectal cancers and coronary heart disease (17–21). The WCRF 2007 report concluded that no firm judgments could be made on any possible relation between dietary patterns and the risk of cancer (16). As new studies have been published in this area, the aim of this systematic review was to critically appraise the literature published to date and to conduct meta-analyses to pool the results of studies to clarify the association between dietary patterns and breast cancer risk.

METHODS
Study selection
An electronic literature search was conducted in Ovid MEDLINE (US National Library of Medicine, Bethesda, MD) and EMBASE (Reed Elsevier PLC, Amsterdam, Netherlands) to identify human studies written in the English language and published up to November 2009 that included the following

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keywords or phrases: breast, breast neoplasms, cancer, carcinoma, diet, dietary, human, mammary, neoplasms, patterns, risk, and tumor. Three independent reviewers read the abstracts of the articles retrieved in the initial search to identify studies that examined diet and breast cancer risk. All reviewers agreed on the relevant articles, and the full-text versions of the articles were reviewed to identify studies that examined food and/or dietary patterns by factor analysis and/or principal component analysis (as opposed to nutrients). Only studies that reported risk estimates [hazards ratios, odds ratios (ORs), and relative risks] of breast cancer and measures of variability (SEs or 95% CIs from which these could be derived) were included.

To minimize error, only the most common patterns of dietary consumption were identified from the remaining articles, and the authors ensured that the selected dietary patterns were similar with regard to factor loadings of foods most commonly consumed within those dietary patterns. For example, studies that identified a Western/unhealthy dietary pattern tended to have high loadings of foods such as red and/or processed meats, refined grains, potatoes, sweets, and high-fat dairy. Prudent/healthy dietary patterns tended to have high loadings of foods such as fruit, vegetables, poultry, fish, low-fat dairy, and whole grains, and drinker dietary patterns tended to have high loadings of wines, beers, and spirits. Studies that identified dietary patterns with similar loadings of the foods common to the Western/unhealthy, prudent/healthy, and drinker patterns but were named differently were also included. In total, 18 studies, 3 of which were from one article (22), met the inclusion criteria and were included in the analyses.

Data extraction

Information extracted from each study included geographic region and design, sample size, duration of follow-up, dietary assessment method, method of identifying and naming dietary patterns, the number of cancer cases, risk estimates with CIs, and factors that were adjusted for in the analysis.

Statistical analyses

The original studies reported the results of dietary patterns in terms of quintiles, quartiles, or tertiles of dietary factor scores and breast cancer risk. Therefore, to combine the results, a meta-analysis was conducted in which we evaluated the risk of breast cancer in women in highest compared with lowest categories of prudent/healthy, Western/unhealthy, and drinker dietary patterns. In addition, the linear increase in breast cancer risk per percentile increase in dietary pattern was estimated by conducting a regression of the adjusted ORs in the categories of dietary patterns against the average percentile in each category where possible by using the methods of Greenland and Longnecker and otherwise using variance-weighted least-squares linear regression (23). This linear increase was converted to an estimate for a 20th-percentile increase in dietary pattern score. Multivariable adjusted hazards ratios, ORs, and relative risks with 95% CIs from individual studies were weighted and combined to produce an overall OR. Random-effects models were used for the analysis. Heterogeneity was tested with a chi-square test and measured by using the $I^2$ statistic (24). Each study’s estimate and SE was used to produce a forest plot that gave a pooled estimate. Publication bias was assessed by a funnel plot and Begg’s and Egger’s tests (25).

Subgroup analyses were conducted for the following studies: case-control and cohort studies; North American, Canadian, and European studies; studies from other countries; studies that reported on prudent/healthy and Western/unhealthy patterns; studies in which patterns were named differently (eg, pork, processed meat, and potatoes; beef/pork-starch; and vegetable-fish/poultry-fruit); studies including menopausal status (where estimates were provided); studies that used diet histories; studies that used food-frequency questionnaires (FFQs); studies adjusted for energy intake; and studies unadjusted for energy intake.

Statistical analyses were conducted with Intercooled STATA version 9.2 (2005; StataCorp, College Station, TX).

RESULTS

Inclusion

The initial search identified 73 potential articles, of which 38 articles were excluded because they did not examine diet and breast cancer. Of the 35 articles that remained (for a list of all 35 articles that were considered in detail, see supplemental material under “Supplemental data” in the online issue), the following articles were excluded: 2 articles (26, 27) that were identified twice, 2 reviews (28, 29), an invited commentary (30), 2 studies (31, 32) that looked at breast cancer survival as opposed to risk, and 2 studies (33, 34) that looked at breast density as opposed to cancer risk. An additional 9 articles were excluded because they did not use dietary patterns that were derived by factor analysis and/or principal components analysis (35–43), and one article was excluded because it used a combination of factor analysis and cluster analysis and could not be used in our analyses (44). Sixteen articles (22, 45–59) [one article (22) that reported on 3 studies] identified prudent/healthy, Western/unhealthy, and/or drinker or similar dietary patterns and thus were included in the analyses (Table 1).

Western/unhealthy dietary pattern

The association between highest compared with lowest categories of intake of Western/unhealthy dietary patterns and breast cancer risk for all studies is shown in Figure 1. When all studies were combined, there was no evidence of a difference in the risk of breast cancer for women in the highest category compared with lowest category (OR = 1.09; 95% CI: 0.98, 1.22; P = 0.11). The heterogeneity was most apparent in the case-control studies (P = 0.000, $I^2 = 63\%$), where an increase in the risk of breast cancer was shown (OR = 1.31; 95% CI: 1.05; 1.63; P = 0.02). In the cohort studies, there was less evidence of heterogeneity (P = 0.13, $I^2 = 35\%$), but there was no evidence of a difference in the risk of breast cancer (OR = 0.99; 95% CI: 0.90; 1.08; P = 0.82). Similar results were observed for all studies per 20th-percentile increase in intake of the Western/unhealthy dietary pattern (OR = 1.02; 95% CI: 0.99, 1.04; P = 0.08) with evidence of heterogeneity (P ≤ 0.000), where an increase in the risk of breast cancer was shown among case-control studies (OR = 1.06, 95% CI: 1.01, 1.11, P = 0.02) with no difference detected between cohort studies.

Prudent/healthy dietary pattern

There was evidence of a decrease in risk of breast cancer in the highest compared with the lowest categories of the prudent/
### TABLE 1

Descriptions of the studies included in the systematic review and meta-analysis of dietary patterns and breast cancer risk

<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Design</th>
<th>Sample size</th>
<th>Diet-assessment method</th>
<th>Dietary patterns identified</th>
<th>Factors adjusted for in analyses (multivariable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terry et al, 2001 (45)</td>
<td>Sweden</td>
<td>Cohort (9.6)</td>
<td>61,463 (1328 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Western; healthy; drinker</td>
<td>Age, energy intake, BMI, education, family history, parity, age at first birth</td>
</tr>
<tr>
<td>Sieri et al, 2004, (46)</td>
<td>Italy</td>
<td>Cohort (9.5)</td>
<td>8984 (207 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Salad vegetable; Western; canteen; prudent</td>
<td>Age, energy intake, education, parity, height, age at menarche, smoking, menopausal status</td>
</tr>
<tr>
<td>Adebamowo et al, 2005 (47)</td>
<td>United States</td>
<td>Cohort (8)</td>
<td>90,638 (710 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Prudent; Western</td>
<td>Age at menarche, parity, age at first birth, family history of breast cancer, history of benign breast disease, oral contraceptive use, alcohol intake, energy intake, current BMI, height, smoking, habit, physical activity and multivitamin use</td>
</tr>
<tr>
<td>Fung et al, 2005 (48)</td>
<td>United States</td>
<td>Cohort (16)</td>
<td>71,058 (3026 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Prudent; Western</td>
<td>Age, smoking status, BMI, multivitamin use, energy intake, physical activity, family history of breast cancer, history of benign breast disease, duration of and age at menopause, use of hormone replacement therapy, age at menarche, parity, age at first birth, BMI at 18 y of age, weight change since 18 y of age, height, alcohol intake</td>
</tr>
<tr>
<td>Mannisto et al, 2005 (22)</td>
<td>Netherlands (NLCS)</td>
<td>Cohort (7)</td>
<td>1,598 (1127 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Vegetable; pork, processed meat, and potatoes</td>
<td>Age, BMI, height, education, smoking, family history of breast cancer, age at menarche, age at first birth, ever use of oral contraceptive, ever use of hormone replacement therapy, alcohol intake, energy</td>
</tr>
<tr>
<td>Italy (ORDET)</td>
<td>Cohort (9)</td>
<td>10,788 (212 cases)</td>
<td>Food-frequency questionnaire</td>
<td>(107; past year)</td>
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<td>Age, BMI, height, education, smoking, family history of breast cancer, ever use of oral contraceptive, ever use of hormone replacement therapy, alcohol intake and energy</td>
</tr>
<tr>
<td>Sweden (SMC)</td>
<td>Cohort (13)</td>
<td>66,651 (1932 cases)</td>
<td>Food-frequency questionnaire</td>
<td>(67; past 6 mo)</td>
<td></td>
<td>Age, BMI, education, family history of breast cancer, age at first birth, parity, alcohol intake and energy</td>
</tr>
<tr>
<td>Nkondjock and Ghadirian, 2005 (49)</td>
<td>Canada</td>
<td>Case-control</td>
<td>414 breast cancer cases/429 controls</td>
<td>Food-frequency questionnaire (985; 2 y before diagnosis, corresponding time for controls)</td>
<td>Chocolate-cereal; pork and processed meat; drinker</td>
<td>Total energy intake, family history of cancer, marital status, physical activity, smoking, BMI, age (at first full-term pregnancy for breast cancer), history of benign breast disease, full-term pregnancies</td>
</tr>
<tr>
<td>Velie et al, 2005 (50)</td>
<td>United States</td>
<td>Cohort (8)</td>
<td>40,559 (1868 cases)</td>
<td>Food-frequency questionnaire</td>
<td>Vegetable-fish/ poultry-fruit; beef-pork starch; traditional Southern</td>
<td>Age, total energy intake, education, family history of breast cancer, BMI, height, parity, age at first live birth, age at menarche, menopausal hormone use, average weekday vigorous physical activity, smoking status, alcohol intake</td>
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</tbody>
</table>

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<table>
<thead>
<tr>
<th>Study</th>
<th>Location</th>
<th>Design</th>
<th>Sample size</th>
<th>Diet-assessment method</th>
<th>Dietary patterns identified</th>
<th>Factors adjusted for in analyses (multivariable)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ronco et al,</td>
<td>Uruguay</td>
<td>Case-control</td>
<td>442 cases/442 controls</td>
<td>Food-frequency questionnaire (64; usual intake)</td>
<td>Traditional; healthy; Western; stew; high-fat; drinker</td>
<td>Age, residence, urban/rural status, education, family history of breast cancer among first-degree relatives, menopausal status, age at menarche, parity, total energy intake</td>
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<td>2006 (51)</td>
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<tr>
<td>Cui et al,</td>
<td>Shanghai</td>
<td>Case-control</td>
<td>1446 cases/1549 controls</td>
<td>Food-frequency questionnaire (76; past 5 y)</td>
<td>Vegetable-soy; meat-sweet</td>
<td>Age, total energy, family history of breast cancer, history of fibroadenoma, age at menarche, live births, age at first live birth, menopausal status, age at menopause, physical activity during the past 10 y, waist-hip ratio, education</td>
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<tr>
<td>2007 (52)</td>
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<tr>
<td>Hirose et al,</td>
<td>Japan</td>
<td>Case-control</td>
<td>1885 cases/22,333 controls</td>
<td>Food-frequency questionnaire [13 diet factors, 17 food items; 1 y before diagnosis/interview (controls)]</td>
<td>Prudent; fatty; Japanese; salty</td>
<td>Age, visit year, motivation, BMI, menopausal status, parity, age at first full-term pregnancy, age at menarche, smoking, drinking, family history of breast cancer, exercise</td>
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<tr>
<td>2007 (53)</td>
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<tr>
<td>Edefonti et al,</td>
<td>Italy</td>
<td>Case-control</td>
<td>2569 BC and 1031 OC/3413 controls</td>
<td>Food-frequency questionnaire [78; 2 y before diagnosis/hospital admission (controls)]</td>
<td>Animal products; vitamins and fiber; unsaturated fats; starch-rich</td>
<td>Age, education, parity, menopausal status, geographic area, BMI, history of female cancers, history of digestive cancers, energy intake</td>
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<tr>
<td>2008 (54)</td>
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<tr>
<td>Murtaugh et al,</td>
<td>United States</td>
<td>Case-control</td>
<td>757 cases/867 controls (Hispanic); 1524 cases/1598 controls (non-Hispanic)</td>
<td>Diet-history Questionnaire (computerized-interviewer administered)</td>
<td>Western; prudent; native Mexican; Mediterranean; dieter</td>
<td>Age, center, education, family history of breast cancer, smoking, total activity, calories, dietary fiber, dietary calcium, height, parity, recent hormone exposure, BMI, interaction of recent hormone exposure and BMI</td>
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<td>2008 (55)</td>
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<tr>
<td>Wu et al,</td>
<td>United States</td>
<td>Case-control</td>
<td>1248 cases/1148 controls</td>
<td>Food-frequency questionnaire (174; usual intake)</td>
<td>Western-meat/starch; ethnic-meat/starch; vegetable-soy</td>
<td>Age, Asian ethnicity, education, birthplace, years of residence in the United States, years of physical activity, marital status, parity, age at menarche, type of menopause, age at menopause, recent BMI</td>
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<tr>
<td>2009 (56)</td>
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<tr>
<td>Cottet et al,</td>
<td>France</td>
<td>Cohort</td>
<td>63,374 (2381 cases)</td>
<td>Diet-history questionnaire</td>
<td>Alcohol/Western; healthy/ Mediterranean</td>
<td>Age, education, region at baseline, BMI, height, family history of breast cancer, age at menarche, age at first full-term pregnancy, number of live births, menopausal hormone therapy, history of benign breast disease, lobular carcinoma in situ, oral contraceptive use, breastfeeding history, frequency of Papanicolaou testing, physical activity, smoking status, energy intake excluding alcohol intake, use of phytoestrogen supplement, use of vitamin/mineral supplements</td>
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<tr>
<td>2009 (57)</td>
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healthy pattern (Figure 2) when all studies were combined (OR = 0.89; 95% CI: 0.82, 0.99; P = 0.02). Among case-control studies only, there was more evidence of heterogeneity (P = 0.000, I² = 85%) and no evidence of an association with disease risk (OR = 0.84; 95% CI: 0.67, 1.05; P = 0.12). In cohort studies, there was less evidence of heterogeneity, (P = 0.51, I² = 0%), and a small decrease in risk of breast cancer was shown (OR = 0.93; 95% CI: 0.88, 0.98; P = 0.01).

In sensitivity analyses, per 20th-percentile increase in intake of the prudent/healthy dietary pattern, no evidence of a difference in risk was shown when all studies were combined (OR = 0.98; 95% CI: 0.96, 1.00; P = 0.07) or for case-control studies (OR = 0.96; 95% CI: 0.92, 1.02; P = 0.23) or cohort studies (OR = 0.99; 95% CI: 0.97, 1.00; P = 0.08).

**Drinker dietary pattern**

Four studies (45, 49, 51, 59) identified a drinker dietary pattern (Figure 3), and when intakes in the highest compared with the lowest categories were combined, an increase in the risk of breast cancer was shown (OR = 1.21; 95% CI: 1.04, 1.41; P = 0.01). The studies showed no evidence of heterogeneity (P = 0.32, I² = 15%).

**Publication bias**

Funnel plots revealed little evidence of asymmetry (not shown) and therefore little evidence of publication bias (highest compared with lowest categories: Western/unhealthy Begg’s test P = 0.509; prudent/healthy Begg’s test P = 0.649; and drinker Begg’s test P = 0.423).

**Sensitivity analyses**

When results were analyzed by removing non-American, non-Canadian, and non–European Union studies (51–53, 59), studies (22, 49, 50, 52–54, 56) that named patterns differently to prudent/healthy and Western/unhealthy patterns, and studies (53, 56) unadjusted for energy intake, no difference in the risk of breast cancer for those in highest compared with lowest categories of prudent/healthy and Western/unhealthy patterns was detected. Similarly, when studies were analyzed by menopausal status, no difference in risk of breast cancer was shown for any of the dietary patterns. When the 2 studies (55, 57) that used diet histories as opposed to FFQs were removed, the decrease in risk of breast cancer that was shown for high compared with low categories of the intake of a prudent/healthy dietary pattern remained (OR = 0.87; 95% CI: 0.78, 0.95; P = 0.003), whereas no evidence of a difference in risk of breast cancer was shown for the intake of the Western/unhealthy dietary pattern.

**DISCUSSION**

To the best of our knowledge, this is the first systematic review and meta-analysis of breast cancer and dietary patterns. The results indicate that a prudent dietary pattern may decrease breast cancer risk, and a drinker dietary pattern may increase breast cancer risk. When the WCRF report was published in 2007, it was judged that there was insufficient evidence to reach a conclusion about the effect that dietary patterns have on breast cancer risk (16). However, 11 of the 18 studies included in our analyses (22, 45, 49, 52–59) were published subsequent to the WCRF 2007 report.

In our analyses, a prudent/healthy dietary pattern was associated with a small decrease in the risk of breast cancer when the results of all studies were pooled, and this inverse association remained when the results of cohort studies alone were pooled. The prudent/healthy dietary patterns included in our analyses had high-factor loadings for plant foods and low-factor loadings for red and processed meat, which is a diet advocated by the WCRF to reduce cancer risk (16). However there are limitations to this type of analysis because the factor loadings for individual foods in the prudent/healthy patterns were not identical between...
studies, resulting in misclassification error. Even modest amounts of measurement error can have a dramatic effect on measures of disease risk, and it is possible that the small inverse association shown is due to a combination of dietary measurement error and misclassification of women into categories of dietary pattern.

FFQs were used to assess dietary intake in the majority of studies (22, 45–54, 58, 59), and diet histories were used in 2 studies (55, 57). In a sensitivity analysis of studies that used a FFQ to collect dietary data, the inverse association between a prudent/healthy dietary pattern and breast cancer risk remained. The results of the 2 studies that used a diet history to assess dietary intake did not show an association with breast cancer risk.

As discussed by Bingham et al (60) and Freedman et al (61), studies that used FFQs to assess intake did not detect relations between fat intake and breast cancer risk, whereas studies that used food diaries and diet histories, both of which are superior methods of dietary assessment, did detect a relations between fat intake and breast cancer risk. Indeed, calibration studies (62, 63) comparing FFQ data to criteria measures of total energy expenditure or protein intake identified substantial amounts of random and systematic variability. Therefore, it is possible that any association shown in this analysis was attenuated toward the null as a result of nondifferential misclassification.

A drinker dietary pattern was associated with an increase in the risk of breast cancer, which is in agreement with the WCRF report (16), which judged alcohol to be a convincing and well-established dietary risk factor for breast cancer. It was hypothesized that an increased alcohol consumption can lead to higher estrogen concentrations because of decreased metabolic clearance and/or increased secretion and can improve the permeability of membranes to carcinogens and inhibit their detoxification (64, 65).

No overall association was shown for a Western/unhealthy dietary pattern and breast cancer risk in our analyses. However, in a sensitivity analysis that included the results of case-control studies only, a Western/unhealthy dietary pattern was positively associated with a breast cancer risk for women in highest compared with lowest categories of dietary pattern and per the 20th-percentile increase in intake. However, a recall bias of dietary intake is always a possibility with case-control studies, and the results should be viewed with caution.

The WCRF (16) supports a low consumption of red and processed meats, which have high loadings in a Western/unhealthy dietary pattern, and therefore, the lack of an association between this dietary pattern and breast cancer risk was surprising, although there was a large degree of heterogeneity between studies, which was most evident among case-control studies.

Although we matched factor loadings as closely as possible between studies, the actual factor loading for the same food within the same dietary pattern was never identical between studies. It is also likely that other variables that could not be accounted for such as cooking methods or food grouping, which

![FIGURE 1. A, B: Forest plot of the highest compared with the lowest categories of intake of the Western/unhealthy dietary pattern and breast cancer risk. NLC, Netherlands Cohort Study on Diet and Cancer; ORD, Ormoni e Dieta nella Eziologia dei Tumori; SMC, Swedish Mammography Cohort.](https://academic.oup.com/ajcn/article-abstract/91/5/1294/4597289)
may be culturally related and may differ by ethnicity. We were unable to perform a sensitivity analysis by ethnic group because the point estimates were not provided in the original articles.

There are potential limitations to our meta-analysis; the pooled findings are directly driven by the included studies, which have their own strengths and weaknesses in terms of study design. In addition, there was a different response rate and inconsistent adjustment for potential confounders among the included studies. Only some of the studies (22, 45–48, 52, 56) included in our analyses provided crude estimates of risk, and differences did exist between these and multivariable adjusted estimates.

In addition, in the included studies, only single time-point measurements of dietary patterns were examined, and these do not account for changes in diet over time. These changes may be especially relevant to cancer development because dietary patterns in childhood and adolescence were associated with an early onset of menarche, which is an early risk factor for breast cancer (66).

In the studies reviewed, it is also possible that there may have been a misclassification within the 3 dietary patterns identified. Factor analysis and/or principal component analysis are subjective techniques with opportunities for variation at almost every step (eg, a variation in the number and type of dietary patterns derived within each study and categories of dietary patterns score) (67–72).

To minimize the risk of bias, the authors selected only the most commonly identified dietary patterns across studies and ensured, as far as possible, that the dietary patterns were similar with regard to factor loadings of foods most commonly consumed, a method that was used by another systematic review (73) that yielded significant associations between prudent and Western dietary patterns and risk of coronary heart disease.

Despite the opportunity for variation in the factor analysis and principal component analysis, reasonable reproducibility was reported when dietary patterns derived from FFQs and those derived from diet histories were compared (74, 75). The long-
term reproducibility and/or stability of the technique was also indicated, but publications in these areas are limited (76).

It is possible that other types of dietary patterns are also relevant to breast cancer risk. We only included the most commonly identified dietary pattern for the purposes of our analyses; therefore, it is possible that associations exist for other dietary patterns and for dietary patterns derived from other techniques such as a priori score-based approaches and reduced rank regression, which uses a combination of a priori and a posteriori techniques. For example, an a priori proinflammatory dietary pattern was associated with type 2 diabetes (77), whereas another a priori score that combined the effects of prooxidant and antioxidant exposures was associated with prostate cancer and colorectal adenoma (78).

In conclusion, our results provide evidence of a small inverse association between a prudent/healthy dietary pattern and a positive association between a drinker dietary pattern and breast cancer risk. To the best of our knowledge, our analysis is the first to examine this association, and the limitations outlined should be considered. The results of these meta-analyses perhaps highlight the need for more carefully designed observational and intervention studies to clarify the role of dietary patterns and breast cancer risk.

The authors’ responsibilities were as follows—SFB: conducted the literature search, extracted the data, prepared the first draft of the article, and contributed to the writing, editing, and proofreading of the final version of the article; JWW and MMC: conducted the literature search, extracted the data, conducted the statistical analyses, and contributed to the writing, editing, and proofreading of the final version of the article; CRC: extracted the data, conducted the statistical analyses, and contributed to the writing, editing, and proofreading of the final version of the article; and LSY: contributed to the writing, editing, and proofreading of the final version of the article. None of the authors declared a conflict of interest.

REFERENCES