Food and Botanical Groupings and Risk of Breast Cancer: A Case-Control Study in Shanghai, China

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Abstract

Breast cancer incidence rates more than double in Chinese women as they migrate from China to Hong Kong to the United States, suggesting that environmental factors contribute to the international variation in breast cancer incidence. Several dietary factors, which differ between the United States and the Chinese population, including intake of soy, meat, and fruits and vegetables, have been suggested to affect breast cancer risk. This report describes results from a case-control study of diet and risk of breast cancer nested in a randomized trial of breast self exam in Shanghai, China. Participating breast cancer cases (n = 378) and frequency age-matched controls (n = 1,070) completed a comprehensive food frequency questionnaire and a risk factor questionnaire. After adjustment for age, total energy intake, and total years of breast-feeding, women in the highest quartile of fruit and vegetable intake (≥3.8 servings/d) were significantly less likely to have breast cancer (odds ratio, 0.48; 95% confidence interval, 0.29-0.78) as compared with women in the lowest quartile of intake (≤2.3 servings/d). Egg consumption was also significantly inversely associated with risk of breast cancer (odds ratio for ≥6.0 eggs/wk versus ≤2.0 eggs/wk is 0.56; 95% confidence interval, 0.35-0.91). There was no difference in soy consumption between cases and controls. None of the associations with a single botanical family explained the strong inverse relationship between fruits and vegetables and breast cancer risk. These results provide additional evidence in support of the important role of fruits and vegetables in breast cancer prevention. (Cancer Epidemiol Biomarkers Prev 2005;14(1):81–90)

Introduction

Breast cancer is the most common nonskin cancer among women in the United States and most other developed countries (average age standardized incidence rate, 63.22/100,000). However, in less developed countries, breast cancer incidence is, on average, thrice lower (average age standardized incidence rate, 23.07/100,000; ref. 1). In China, breast cancer incidence per 100,000 is 5.6 times lower than in the United States (average age standardized incidence rate, 16.39 versus 91.39). Yet both breast cancer incidence and mortality rates have been increasing in China during the past two decades (2). Whereas the factors responsible for the increasing rate of breast cancer in China remain unknown, this increase has been correlated with changes in dietary intake over the past 20 years, including an increase in the percent of calories derived from animal foods (3, 4).

Data from studies of migrant populations support this hypothesis that dietary changes, specifically the transition from under to overnutrition, may alter risk of disease. As women move from low-risk to high-risk countries, their incidence of breast cancer increases to reflect that of the host country and this risk remains elevated in subsequent generations (5, 6). This shift in incidence typically occurs quickly with increases seen in the migrating generation and levels of risk equaling that of the host country within one to two generations as migrants become more acculturated to a Western lifestyle, including Western dietary patterns (7). We hypothesized that the dietary intake of women in Shanghai, China during the years of study would reflect the dietary changes commonly seen among migrant women and may therefore provide an opportunity to study the impact of a range of dietary exposures within a single population on breast cancer risk.

There is a wealth of studies regarding diet and risk of breast cancer in Western countries, yet there are few conclusive findings. The most frequently reported associations are an increase in risk with high fat or meat intake and a reduction in risk with fruit and vegetable consumption. However, findings from studies remain inconsistent (8, 9). Several investigators have evaluated the association between these dietary factors as well as soy intake and breast cancer risk in a Chinese population where exposure to potential dietary risk factors may be different from that seen in most Western countries (lower consumption of fat and meat, higher consumption of soy, fruits, and vegetables; refs. 10-13). However, again, the results have been inconsistent.

In this paper, we report findings from a case-control study of dietary intake and breast cancer risk. This study was conducted among participants of a randomized trial of breast self-exam (BSE) in Shanghai, China. The primary aims of the study were to investigate possible associations between intake of fruits and vegetables, soyfoods, and meat and breast cancer risk.

Materials and Methods

Study subjects were selected from participants in the BSE trial, details of which have been described elsewhere (14, 15). Briefly, over 266,000 current and retired female employees of 519 Shanghai Textile Industry Bureau factories were recruited and randomized to either a BSE education or control group. Eligible women were born between 1925 and 1958, were permanent residents of Shanghai and were either current or

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retired textile factory employees. Between 1989 and 1991, all eligible women completed a baseline questionnaire to obtain information on the major recognized risk factors for breast cancer; alcohol and tobacco use, contraceptive practices, prior breast cancer, and previous clinical or self breast examinations. All participants who reported a suspicious breast lump through July 2000 were initially evaluated by medical workers in clinics in each factory, and, if indicated, referred to a surgeon at one of three hospitals operated by the Shanghai Textile Industry Bureau and affiliated with the factories, or at other hospitals having contractural arrangements with individual factories. Pathology slides were obtained for standardized review. Tumor size, histologic diagnosis, and stage at diagnosis were obtained from review of the medical record and stored slides from all biopsies were re-reviewed in Seattle. Over the 10-year follow-up period, 857 intervention and 890 control women were diagnosed with histologically confirmed breast cancer.

Women referred to one of three hospitals operated by the Shanghai Textile Industry Bureau for evaluation of a breast lump, and who had a breast biopsy between September 1995 and July 2000, were eligible for inclusion in the present study. A total of 1,429 women underwent biopsy and were considered for inclusion. Of these women, 375 were diagnosed with fibroadenoma, 622 were diagnosed with nonproliferative or proliferative fibrocystic disease, and 432 women with breast cancer. Whereas all women undergoing biopsy were eligible for recruitment into the diet study, only women with histologically confirmed breast cancer were included as cases in the present analyses.

As described above, a total of 432 eligible women were diagnosed with histologically confirmed breast cancer and of these, 368 (85%) completed a food frequency questionnaire and risk factor questionnaire prior to biopsy. An additional 16 women were admitted immediately to surgery and completed the interview following surgery. Six women with breast cancer were excluded due to prior mastectomy (n = 4) or prior diagnosis of breast cancer (n = 2) recorded on the baseline questionnaire, yielding a final sample of 378 breast cancer cases. Among the breast cancer cases, 184 were diagnosed between September 1995 and August 1997 and were also enrolled in a concurrent nested case-control study of cell proliferation. The remaining 194 cases were recruited after August 1997 and were recruited solely into the present study.

Controls for the present study were selected from the unaffected women in the BSE trial cohort. For cases also enrolled in the cell proliferation study, 20 potential controls of the same age as the corresponding case, from factories with the same hospital affiliation at the start of the BSE trial as the cases' factory, were randomly selected and listed. Women were contacted, starting with the first two names on the list, until two women with the same age and menstrual status of their matched case were recruited. All 367 controls recruited in this manner (64% of the eligible women contacted) were included in the analyses for this report; this includes the controls selected for the cases of benign breast conditions in the cell proliferation study, so the matching was not retained in the analyses. Controls for the cases that were recruited after the termination of the cell proliferation study were frequency matched to eligible cases for this study, including the cases of benign breast conditions that are not included in this report, by 5-year age group and hospital affiliation of their factories at baseline. In-person interviews were completed for 704 (82%) of the 862 controls selected in this manner. The same team of interviewers conducted the interviews for both consenting controls and cases. One control woman was excluded due to a calculated daily energy intake of over 4,000 kcal that was considered unreliable. Thus, a total of 1,070 controls were included for our analyses.

Dietary data were collected using an interviewer-administered food frequency questionnaire (FFQ) that was based on a questionnaire previously validated in a Shanghai population (16). The FFQ consisted of 115 individual food items, plus additional items asking about recent dietary changes, consumption of ''Western'' and fast food or other restaurant foods (20 items) and use of herbal remedies and supplements. Each woman was asked to report how frequently per day, week, month, or year she ''usually'' ate each food in her adult life. If the woman reported having recently changed her diet, she was asked to report her level of consumption prior to the change. Because many traditional Chinese dishes consist of mixed foods, the women were asked to consider each time she ate the food even if it was part of a mixed dish.

A team of specially trained former medical clinic workers reviewed the modified FFQ and evaluated it for content validity through interviews with nonstudy women and semi-structured feedback. Based on comments and experience from the team, it was concluded that requesting portion size information would be too imprecise, given that foods are often consumed as part of a mixed dish and that frequently all family members will eat out of a common pot rather than being served an individual portion. Portion size was therefore estimated based on the median portion size of women respondents from the 1992 Chinese Health and Nutrition Survey, a series of three, 24-hour recalls conducted among persons living in urban and rural China (17). Oil use in cooking was captured through items asking solely about the amount of oil used by the family per month. An estimate of the amount of oil consumed by the woman was then determined by dividing the total quantity of oil reported for the family by the number of family members (as reported on the detailed reproductive health questionnaire described below). Seasonality of fruits and vegetables was accounted for by asking subjects to report how many months of the year they consumed the item and the frequency of consumption during those months.

A detailed reproductive health questionnaire was completed at the same time as the FFQ. This questionnaire elicited information on the woman's demographic characteristics, reproductive and gynecologic history, smoking and alcohol habits, medical history, family history of breast cancer, and occupational and recreational physical activity.

Informed consent was obtained from each woman before interview. The Institutional Review Board of the Fred Hutchinson Cancer Research Center and the Station for Prevention and Treatment of Cancer of the Shanghai Textile Industry Bureau approved the study, in accordance with the assurances of the Office for Human Research Protections of the U.S. Department of Health and Human Services.

Food groupings were constructed based on nutritional similarity (e.g., meats, dairy, fruits, and vegetables); fruits and vegetables were further grouped based on botanical family (see Appendix A). Individual food consumption was converted to a daily frequency variable. Individual values for the foods in each group were summed to create frequencies of consumption for that group. To assess potential trends in risk with level of consumption, each food group was divided into quartiles according to the distribution of consumption among controls. Tertiles or dichotomous categories were created for food and botanical groups with too little variation in intake to create meaningful quartiles.

The nutrient composition of each food item was based upon values provided in the 1991 Chinese Food Composition Tables (18) and the University of Minnesota Nutrition Coordinating Center's Nutrient Data System. Total caloric intake was calculated based upon food and oil consumption.

The frequency of the demographic and reproductive characteristics in the cases and controls were compared, and the percentages among the cases were standardized to the age distribution of controls, using indirect adjustment methods (19). Conditional logistic regression models were used to calculate odds ratios (OR) as estimates of the relative risks and their 95% confidence interval (95% CI) for breast cancer associated with each level of dietary intake (20). All statistical analyses were done using the Statistical Analysis System (SAS/PC V. 8.2 program, SAS Institute, Cary, NC) and tests were considered statistically significant at $P < 0.05$. Because cases and controls were not recruited and interviewed at an equal rate over the 5 years of data collection, we used conditional multiple logistic regression models stratified by year of interview (1995-1996, 1997, 1998-1999, and 2000-2001). Because the women with fibrocystic disease and fibroadenoma tended to be younger than the women with breast cancer, and because the controls were age matched to these women as well as to the breast cancer cases, the mean age of the controls is significantly younger than the mean age of the breast cancer cases. ORs for each level of dietary intake were therefore adjusted for age, using 5-year age categories. Food group models were further adjusted for total energy intake (21). To address whether specific fruits or vegetables within a particular botanical group altered risk apart from their contribution to overall fruit and vegetable intake, the botanical group models were adjusted for total fruit and vegetable consumption. Botanical models were also adjusted for total energy intake. However, the addition of total energy intake did not substantially alter the OR for any of the botanical groupings; thus, total energy was not maintained in the final botanical group models. In addition, food groups were also modeled using a Multiple Nutrient Density model as described by Willett (22). Density values were calculated for each food group (food group intake/total daily energy) and entered into the conditional logistic model together with total daily energy and age (data not shown). The results using the Multiple Nutrient Density model did not differ appreciably from those presented. Results based on the energy or fruit and vegetable adjusted models are presented.

Potential confounding by other nondietary factors and instruction arm of the BSE trial was evaluated by adding each variable independently associated with breast cancer risk to the model separately. Family history of breast cancer, age at menarche, age at first full-term pregnancy, age at first live birth, total live births, number of prior benign breast lumps, duration of oral contraceptive use, duration of intrauterine device use, number of induced abortions, menopausal status, years of breastfeeding, years since last induced abortion, frequency of BSE practice, education, smoking, alcohol use, body mass index, and physical activity were evaluated as possible confounders. Variables were considered confounders if they changed the estimated OR of the main independent variable by ≥10%. Only total years of breastfeeding was maintained as a covariate in the final models. To assess the potential effect modification due to menopause, we stratified the data set based on menopausal status as determined at the time of the interview. The significance of a trend in risk across levels of intake was evaluated by entering quartiles of a food or botanical group into the logistic model as different values of a single ordinal variable. The P value for trend for each food group (i.e., for each increasing category of intake) is presented. Additionally, to account for any potential confounding among the dietary variables, all mutually exclusive groups of dietary variables with significant associations with breast cancer risk were entered simultaneously into a multiple logistic regression model.

Results

As shown in Table 1, in a conditional logistic regression model stratified by year of interview and adjusted for age, the cases were significantly older, were more likely to have greater than high-school education, and were more likely to have had a family history of breast cancer. Cases were less likely to breast feed for an extended duration, were more likely to have had an induced abortion in the past 10 years and were more likely to report performing breast self-exams in the past year (Table 2).

Table 1. Selected characteristics of breast cancer cases and control women, Shanghai, China

Characteristic	Cases, n = 378 (%)	Controls, n = 1,070 (%)
Age (y)		
35-39	14 (3.7)	13 (1.2)
40-44	99 (26.2)	470 (43.9)
45-50	80 (21.2)	219 (20.5)
50-59	56 (14.8)	124 (11.6)
>60	129 (34.1)	244 (22.8)
	Cases, n = 378 (age-adjusted %)	Controls, n = 1,070 (%)
Education (years completed)†		
Elementary school or less	112 (20.2)	211 (19.7)
Middle school	236 (72.5)	827 (77.3)
College	30 (7.3)	31 (2.9)
1° Family history of breast cancer‡	16 (4.3)	17 (1.6)
Body mass index (kg/m^2)		
≤20	62 (16.7)	204 (19.1)
21-25	220 (60.8)	627 (58.6)
≥26	96 (22.5)	239 (22.3)
Spouse smoking: no. cigarettes/d		
Nonsmoker	146 (35.6)	380 (35.5)
1-9 cigarettes	56 (16.6)	119 (11.1)
10-19 cigarettes	74 (21.1)	213 (19.9)
≥20 cigarettes	102 (26.8)	358 (33.5)
Physical activity		
Light	89 (24.7)	195 (18.2)
Moderate	275 (71.8)	804 (75.1)
Heavy	14 (3.5)	71 (6.6)

NOTE: P value for age-adjusted model stratified by year of interview (1995-1996, 1997, 1998-1999, and 2000-2001), using conditional logistic regression.
*Indirect age-adjusted percentages based on age distribution of the controls.
†$P < 0.05$.
‡$P < 0.01$.

As shown in Table 3, total fruit and vegetable intake was associated with ~50% reduction in risk of breast cancer. The association was somewhat stronger for fruit intake, a 65% reduction from highest to lowest category of intake, than for fresh vegetable intake, and not observed for salted or preserved vegetables. There were no associations of any of the soyfood categories, including total soyfood, unfermented soyfood, fermented bean curd and other legumes, or intake of total meat, poultry, or salted and preserved meat with risk of breast cancer. Total seafood was not statistically significantly associated with risk, but ORs were >1.0 for all levels of consumption of unsalted fish above the first quartile. Egg consumption was associated with a significantly reduced risk of breast cancer, and there was a 40% reduction in risk of breast cancer among women who used sesame oil for cooking compared with those that did not. No associations were observed with other oils, fried foods, total preserved foods, milk products, rice, other grains, or desserts.

To investigate the extent to which certain botanical groupings of fruits and vegetables explained the significant inverse association between total fruits and vegetables and breast cancer risk, we modeled the association between breast cancer and 23 discrete botanical families, adjusted for total fruit and vegetable intake (Table 4). Intakes of Araliaceae (fresh ginseng and red and white ginseng powder) and Umbelliferae (celery and carrots) were associated with a significant increase in risk, whereas Ebenacea (persimmon) and Nymphaeaceae (lotus rhizomes) were associated with a significantly reduced risk.

To determine possible confounding between the different food groupings, we created a multivariate model including all mutually exclusive food groupings, including the following dairy products, rice, other grains, fruits, preserved

Table 2. Selected reproductive characteristics of breast cancer cases and control women, Shanghai, China

Characteristic	Cases, n = 378 (age-adjusted %)*	Controls, n = 1,070 (%)
Age at menarche		
≤13	66 (19.9)	171 (15.6)
14	69 (19.9)	204 (19.1)
15	91 (23.2)	215 (20.1)
16	68 (16.8)	221 (20.7)
≥17	84 (20.1)	257 (24.0)
No. live births		
0	21 (5.4)	41 (3.8)
1	193 (63.6)	713 (66.6)
2	66 (13.4)	124 (11.6)
>3	97 (17.4)	188 (17.6)
Missing	1 (0.2)	4 (0.4)
Age at 1st live birth (y)		
No live birth	21 (5.4)	41 (3.8)
≤24	118 (21.9)	275 (25.7)
25-29	170 (52.4)	599 (56.0)
≥30	65 (19.5)	151 (14.1)
Missing	4 (0.8)	4 (0.4)
Duration of breast-feeding† (mos)		
Never	73 (21.5)	233 (21.8)
≤6	69 (20.0)	209 (19.5)
7-12	104 (32.5)	361 (33.7)
13-24	55 (11.6)	115 (10.8)
≥25	77 (13.9)	152 (14.2)
Duration of oral contraceptive use (y)		
Never used	332 (89.0)	978 (91.4)
≤1	21 (5.8)	35 (3.3)
≥1	25 (5.3)	56 (5.2)
Induced abortions		
0	163 (40.7)	437 (40.8)
1	138 (37.1)	427 (39.9)
≥2	56 (16.8)	167 (15.6)
Missing	21 (5.4)	39 (3.7)
Years since last induced abortion†		
None	163 (40.7)	437 (40.8)
0-10	41 (14.6)	129 (12.1)
11-15	49 (16.7)	185 (17.3)
16-20	29 (7.6)	120 (11.2)
>20	54 (10.1)	145 (13.6)
Missing years	42 (10.3)	54 (5.1)
No. prior benign breast lumps		
0	360 (94.5)	1,038 (97.0)
1	13 (3.9)	22 (2.1)
≥2	5 (1.6)	10 (0.9)
Times breast self-examination/y‡		
0	198 (50.8)	725 (67.8)
1-6	80 (21.4)	137 (12.8)
7-12	85 (23.8)	198 (18.5)
≥13	10 (3.1)	7 (0.7)
Missing	5 (0.9)	3 (0.2)
Menopause		
No	187 (62.7)	687 (64.2)
Yes	191 (37.3)	383 (35.8)

NOTE: P value for age-adjusted model stratified by year of interview (1995-1996, 1997, 1998-1999, and 2000-2001), using conditional logistic regression.
*Indirect age-adjusted percentages based on age distribution of the controls.
†$P < 0.01$.
‡$P < 0.01$.

and unpreserved vegetables, fermented bean curd, other nonfermented soy products, nonsoy legumes, red meat, unsalted fish, poultry, eggs, shellfish, cured meat sesame oil, and soybean oil. These results did not significantly differ from those presented (data not shown).

Discussion

In this study, the strongest associations observed were a reduction in risk of breast cancer with increasing consumption of fruits and vegetables. There were no significant trends in risk with soy or meat product intake. However, the ORs for red meat, and unsalted fish, were somewhat greater than one for all levels of intake above baseline. Frequent egg consumption was associated with a statistically significant reduction in breast cancer risk, as was use of sesame oil.

Food Groupings. In 1997, an expert panel of the World Cancer Research Fund/American Institute of Cancer Research judged there to be a probable association between high fruit and vegetable consumption and reduced risk of breast cancer, based upon the findings of three cohort and 19 case-control studies (23). In a recent population-based case-control study of breast cancer in Shanghai, China, Malin et al. reported no association with total fruit and vegetable intake; but a significant reduction in risk of breast cancer associated with specific vegetable groups (e.g., dark yellow-orange vegetables, dark green vegetables, and Chinese white turnips) and with total fruit excluding watermelon (10). Few other studies of fruit and vegetable intake and breast cancer risk in China have been reported. However, both Qi et al. and Yuan et al. reported a significant reduction in risk of breast cancer with increasing total grams of vegetable (24) or other components of fruits and vegetables (12). However, a pooled analysis of eight prospective studies, conducted largely in western countries, suggested that fruit and vegetable consumption in adulthood is not significantly associated with breast cancer risk (25).

Some investigators have suggested that these inconsistent results may be due to inadequate variability in fruit and vegetable intake in many Western populations. In the present study, we report a significant inverse association with breast cancer risk among women consuming fruits and vegetables at a similar level to that reported in most Western studies (26, 27). However, the level of intake in our study may have been underestimated because of the difficulty in estimating total vegetable consumption in mixed Chinese dishes. It is also possible that there are qualitative and quantitative differences in the nutrients derived from the fruits and vegetables consumed due perhaps to differences in the types of fruits and vegetables available, or due to differences in the storage and processing practices in Chinese and Western populations. Early harvest and long-term storage of produce are more common practices in Western countries and may reduce the content of some beneficial nutrients.

Soyfoods have an exceptionally high content of isoflavones, such as genistein and daidzein that have been hypothesized to reduce breast cancer risk through their activity as weak nonsteroidal estrogens (28, 29). This hypothesis has been supported by ecologic studies showing lower breast cancer incidence in populations that typically consume a diet high in soyfoods (30, 31). However, results from case-control studies of high soy consuming Chinese women in Singapore (32), in Shanghai and Tianjin, China (12), and in Shanghai (33) have been inconsistent. A prospective study of women in Japan reported that intake of miso soup and isoflavones, but not of total soyfood intake, was inversely associated with breast cancer risk (34). Two studies report a significant inverse association between intake of soy in adolescence and overall breast cancer risk (11, 35). Our finding of no statistically significant association between soyfoods and breast cancer risk provides additional evidence suggesting that soy intake in adulthood may be of less importance in breast cancer etiology. We did not attempt to assess adolescent intake of soyfoods in the present study.

A number of recent studies have found meat intake to be a risk factor for breast cancer independent of total fat or protein intake (26, 36, 37). Meat, depending upon processing and cooking methods, may be a source of heterocyclic amines, *N*-nitroso compounds and polyaromatic hydrocarbons, all of which have been shown to be mammary carcinogens in rodents and some in human breast cell cultures (38-42). The statistically nonsignificant association that we observed

Table 3. Intake of selected food groups among women in Shanghai, China and risk of breast cancer

Quartiles of intake (servings)					
Food group	1	2	3	4	*P* for trend
Total fruit and vegetable	≤2.3/d	<3.0/d	<3.8/d	≥3.8/d	
No. cases/controls	103/260	80/270	76/267	119/273	
OR (95% CI)*	1.00	0.69 (0.43-1.12)	0.58 (0.35-0.94)	0.47 (0.29-0.77)	0.002
OR (95% CI)†	1.00	0.71 (0.44-1.14)	0.59 (0.36-0.96)	0.48 (0.29-0.78)	0.003
Fruit	≤3.9/wk	<5.9/wk	<1.2/d	≥1.2/d	
No. cases/controls	112/269	83/266	93/268	90/267	
OR (95% CI)*	1.00	0.60 (0.37-0.97)	0.49 (0.31-0.78)	0.35 (0.22-0.57)	<0.001
OR (95% CI)†	1.00	0.59 (0.36-0.96)	0.48 (0.30-0.76)	0.34 (0.21-0.55)	<0.001
Vegetable (unsalted)	≤1.5/d	<2/d	<2.6/d	≥2.6/d	
No. cases/controls	118/268	80/265	74/269	106/268	
OR (95% CI)*	1.00	0.80 (0.51-1.26)	0.74 (0.46-1.18)	0.59 (0.37-0.93)	0.02
OR (95% CI)†	1.00	0.81 (0.51-1.27)	0.76 (0.48-1.22)	0.60 (0.38-0.94)	0.03
Salted/preserved vegetable	≤0.5/mo	<1.3/mo	<1.1/wk	≥1.1/wk	
No. cases/controls	84/293	67/243	77/268	150/266	
OR (95% CI)*	1.00	0.71 (0.44-1.13)	0.71 (0.45-1.11)	0.87 (0.57-1.32)	0.64
OR (95% CI)†	1.00	0.72 (0.45-1.16)	0.70 (0.45-1.11)	0.87 (0.57-1.32)	0.61
Total soyfood	≤2.6/wk	<4.4/wk	<1.1/d	≥1.1/d	
No. cases/controls	78/272	87/263	100/269	113/266	
OR (95% CI)*	1.00	0.97 (0.61-1.54)	1.30 (0.82-2.06)	1.06 (0.67-1.66)	0.57
OR (95% CI)†	1.00	0.96 (0.60-1.53)	1.33 (0.84-2.12)	1.07 (0.68-1.69)	0.51
Unfermented soyfood	≤2.3/wk	<4.2/wk	<1.0/d	≥1.0/d	
No. cases/controls	79/269	91/266	96/268	112/267	
OR (95% CI)*	1.00	1.06 (0.67-1.67)	1.22 (0.77-1.92)	1.20 (0.77-1.88)	0.36
OR (95% CI)†	1.00	1.04 (0.66-1.66)	1.23 (0.77-1.95)	1.22 (0.78-1.92)	0.31
Fermented beancurd	0/y	>0/y			
No. cases/controls	135/446	243/624			
OR (95% CI)*	1.00	0.92 (0.67-1.27)			0.92
OR (95% CI)†	1.00	0.92 (0.67-1.27)			0.62
Other legumes	≤1.9/wk	<2.7/wk	<3.9/wk	≥3.9/wk	
No. cases/controls	102/268	77/268	95/266	104/268	
OR (95% CI)*	1.00	0.72 (0.45-1.15)	1.00 (0.63-1.58)	0.76 (0.48-1.21)	0.46
OR (95% CI)†	1.00	0.73 (0.46-1.17)	1.01 (0.64-1.60)	0.78 (0.49-1.24)	0.53
Milk products	≤1.0/mo	<2.6/wk	<1.0/d	≥1.0/d	
No. cases/controls	134/252	94/279	101/267	49/272	
OR (95% CI)*	1.00	0.91 (0.60-1.38)	1.15 (0.74-1.78)	0.91 (0.54-1.53)	0.97
OR (95% CI)†	1.00	0.89 (0.58-1.35)	1.12 (0.71-1.74)	0.87 (0.52-1.47)	0.90
Total meat (unsalted)	≤2.9/wk	<4.2/wk	<5.9/wk	≥5.9/wk	
No. cases/controls	83/269	80/268	97/269	118/264	
OR (95% CI)*	1.00	1.02 (0.63-1.64)	1.43 (0.89-2.32)	1.12 (0.70-1.80)	0.46
OR (95% CI)†	1.00	1.00 (0.62-1.61)	1.42 (0.88-2.30)	1.12 (0.70-1.80)	0.45
Red meat	≤3.0/wk	<4.4/wk	<6.1/wk	≥6.1/wk	
No. cases/controls	84/270	84/266	85/269	125/265	
OR (95% CI)*	1.00	1.11 (0.69-1.78)	1.40 (0.86-2.29)	1.22 (0.76-1.96)	0.34
OR (95% CI)†	1.00	1.10 (0.69-1.77)	1.41 (0.87-2.31)	1.24 (0.77-1.99)	0.30
Poultry	≤2/mo	<4/mo	<1.2/wk	>1.2/wk	
No. cases/controls	106/255	102/270	91/287	79/258	
OR (95% CI)*	1.00	1.03 (0.68-1.56)	1.08 (0.70-1.67)	0.95 (0.60-1.52)	0.95
OR (95% CI)†	1.00	1.04 (0.68-1.58)	1.10 (0.71-1.70)	0.94 (0.59-1.49)	0.90
Eggs	≤2.0/wk	<3.0/wk	<6.0/wk	≥6.0/wk	
No. cases/controls	129/257	68/190	116/346	65/277	
OR (95% CI)*	1.00	0.71 (0.45-1.12)	0.67 (0.44-1.01)	0.56 (0.35-0.91)	0.02
OR (95% CI)†	1.00	0.72 (0.45-1.13)	0.68 (0.45-1.02)	0.56 (0.35-0.91)	0.02
Total seafood	≤1.9/wk	<2.9/wk	<4.3/wk	≥4.3/wk	
No. cases/controls	87/273	82/274	105/260	104/263	
OR (95% CI)*	1.00	1.23 (0.78-1.94)	1.62 (1.02-2.55)	1.28 (0.81-2.01)	0.19
OR (95% CI)†	1.00	1.23 (0.78-1.96)	1.62 (1.03-2.57)	1.28 (0.81-2.02)	0.20
Fish (unsalted)	≤1.3/wk	<2.2/wk	<3.2/wk	≥4.3/wk	
No. cases/controls	74/273	96/320	96/233	112/244	
OR (95% CI)*	1.00	1.50 (0.95-2.36)	1.64 (1.02-2.65)	1.57 (0.98-2.49)	0.07
OR (95% CI)†	1.00	1.50 (0.95-2.37)	1.63 (1.01-2.63)	1.55 (0.97-2.48)	0.08
Shellfish	≤1.0/mo	<2.0/mo	<1.0/wk	≥1.0/wk	
No. cases/controls	84/153	91/261	89/234	114/422	
OR (95% CI)*	1.00	0.73 (0.45-1.16)	0.82 (0.50-1.34)	0.75 (0.47-1.19)	0.38
OR (95% CI)†	1.00	0.74 (0.46-1.19)	0.82 (0.50-1.34)	0.76 (0.48-1.20)	0.39
Cured meats	≤0.5/mo	<1.2/mo	≥2.0/mo		
No. cases/controls	148/395	109/358	121/317		
OR (95% CI)*	1.00	1.08 (0.74-1.58)	1.17 (0.81-1.70)		0.40
OR (95% CI)†	1.00	1.10 (0.75-1.61)	1.20 (0.82-1.74)		0.35
Rice	≤2.0/d	>2.0/d			
No. cases/controls	70/386	308/684			
OR (95% CI)*	1.00	1.42 (0.97-2.08)			0.07
OR (95% CI)†	1.00	1.43 (0.98-2.10)			0.07

(Continued on following page)

Table 3. Intake of selected food groups among women in Shanghai, China and risk of breast cancer (Cont'd)

Quartiles of intake (servings)					
Food group	1	2	3	4	*P* for trend
Grains except rice and corn	≤3.2/wk	<5.5/wk	<1.2/d	≥1.2/d	
No. cases/controls	113/274	103/262	92/268	70/266	
OR (95% CI)*	1.00	1.30 (0.84-1.99)	1.34 (0.85-2.11)	1.31 (0.78-2.23)	0.26
OR (95% CI)†	1.00	1.27 (0.82-1.95)	1.32 (0.84-2.08)	1.28 (0.76-2.18)	0.30
Sesame oil (used in cooking)	0/y	>0/y			
No. cases/controls	122/146	256/924			
OR (95% CI)*	1.00	0.59 (0.41-0.84)			0.004
OR (95% CI)†	1.00	0.58 (0.41-0.84)			0.004
Soy oil (used in cooking)	≤2.4/mo	<3.2/mo	<4.1/mo	≥4.1/mo	
No. cases/controls	107/268	99/295	101/265	71/242	
OR (95% CI)*	1.00	0.83 (0.54-1.28)	1.00 (0.65-1.54)	0.70 (0.43-1.12)	0.28
OR (95% CI)†	1.00	0.85 (0.55-1.31)	0.99 (0.64-1.53)	0.71 (0.44-1.15)	0.29
Total preserved/ cured foods‡	≤1.7/mo	<3.6/mo	<1.9/wk	≥1.9/wk	
No. cases/controls	79/271	72/268	75/266	152/265	
OR (95% CI)*	1.00	0.93 (0.58-1.47)	0.77 (0.48-1.24)	1.05 (0.69-1.61)	0.85
OR (95% CI)†	1.00	0.95 (0.60-1.52)	0.77 (0.48-1.24)	1.07 (0.70-1.63)	0.84
Fried foods	≤2.8/mo	<1.2/wk	<2.4/wk	≥2.4/wk	
No. cases/controls	90/263	73/277	102/265	113/265	
OR (95% CI)*	1.00	0.55 (0.35-0.89)	0.72 (0.45-1.14)	0.80 (0.50-1.26)	0.66
OR (95% CI)†	1.00	0.54 (0.34-0.87)	0.70 (0.44-1.12)	0.77 (0.49-1.23)	0.57
Desserts	≤1.0/wk	<2.5/wk	<6.0/wk	≥6.0/wk	
No. cases/controls	140/278	86/262	93/263	59/267	
OR (95% CI)*	1.00	0.84 (0.55-1.27)	1.22 (0.79-1.87)	1.13 (0.69-1.86)	0.41
OR (95% CI)†	1.00	0.83 (0.55-1.26)	1.21 (0.79-1.87)	1.09 (0.67-1.81)	0.46

NOTE: All analyses stratified by year of interview (1995-1996, 1997, 1998-1999, and 2000-2001), using conditional logistic regression.
*Adjusted for age and total energy intake.
† Adjusted for age, total energy intake, and breast-feeding.
‡ Preserved vegetables and cured meats and fish.

between the intake of red meat and risk of breast cancer is weakly supportive of a possible effect of meat on the development of this disease. Whereas cooking meats at a high temperature is common in Chinese food preparation (33), we did not ascertain cooking methods and are thus unable to determine whether these possible associations represent relationships with foods cooked in such a manner as to form heterocyclic amines (43).

Findings from previous studies of egg consumption and risk of breast cancer are inconsistent (13, 44). A nested case-control study reported a significant reduction in risk of breast cancer with consumption of an egg per day during adolescence, whereas in a pooled analysis authors report a J-shaped association for egg consumption, with a reduction in risk among women consuming less than two eggs per week and an increase in risk among women consuming one or more eggs per day (45, 46). In the present study, women in the highest category of egg intake had nearly a 50% lower risk of breast cancer than women in the lowest category of intake. Several epidemiologic studies have reported a positive association between egg consumption and risk of colorectal cancer, with most suggesting that this association may be due to the cholesterol content of eggs (as reviewed in ref. 47). However, eggs have also gained attention for their contribution of sphingolipids to the diet. Sphingolipids, and metabolites of sphingolipids (ceramides and sphingosines) are bioactive and

Table 4. Intake of foods in selected botanical groups among women in Shanghai, China and risk of breast cancer

Quartiles of intake					
Servings per day	1	2	3	4	*P* for trend
Araliaceae	0	>0			
No. cases/controls	286/861	92/209			
OR (95% CI)*	1.00	1.56 (1.07-2.29)			0.03
OR (95% CI)†	1.00	1.59 (1.08-2.34)			0.02
Compositae	0	>0			
No. cases/controls	25/31	353/1039			
OR (95% CI)*	1.00	0.58 (0.29-1.18)			0.13
OR (95% CI)†	1.00	0.58 (0.28-1.17)			0.13
Convovulaceae/ Dioscoreaceae	0	>0			
No. cases/controls	99/305	279/765			
OR (95% CI)*	1.00	0.92 (0.65-1.30)			0.64
OR (95% CI)†	1.00	0.94 (0.66-1.33)			0.72
Crucifeae	≤3.1/wk	<4.8/wk	<1.04/d	≥1.04/d	
No. cases/controls	98/269	98/267	103/269	79/265	
OR (95% CI)*	1.00	1.22 (0.76-1.95)	1.19 (0.72-1.95)	1.04 (0.60-1.81)	0.93
OR (95% CI)†	1.00	1.24 (0.77-1.99)	1.21 (0.74-2.00)	1.08 (0.62-1.89)	0.83
Cucurbitaceae	≤2.8/wk	<3.6/wk	<4.7/wk	≥4.7/wk	
No. cases/controls	119/268	95/267	90/268	74/267	

(Continued on following page)

Table 4. Intake of foods in selected botanical groups among women in Shanghai, China and risk of breast cancer (Cont'd)

Quartiles of intake					
Servings per day	1	2	3	4	*P* for trend
OR (95% CI)*	1.00	0.84 (0.52-1.33)	0.81 (0.48-1.35)	0.73 (0.43-1.24)	0.27
OR (95% CI)†	1.00	0.84 (0.53-1.35)	0.81 (0.49-1.37)	0.74 (0.43-1.26)	0.29
Ebenaceae	≤2/y	<4/y	≥4/y		
No. cases/controls	224/586	53/163	101/321		
OR (95% CI)*	1.00	0.89 (0.55-1.44)	0.60 (0.42-0.86)		0.006
OR (95% CI)†	1.00	0.88 (0.54-1.42)	0.60 (0.42-0.86)		0.006
Laminariaceae	0	>0			
No. cases/controls	117/248	261/822			
OR (95% CI)*	1.00	0.78 (0.55-1.12)			0.18
OR (95% CI)†	1.00	0.79 (0.55-1.13)			0.19
Liliaceae	≥3.2/mo	<3/wk	<1/d	≥1/d	
No. cases/controls	135/267	94/272	84/273	65/258	
OR (95% CI)*	1.00	0.65 (0.43-0.99)	1.40 (0.90-2.18)	0.81 (0.49-1.33)	0.86
OR (95% CI)†	1.00	0.65 (0.43-0.99)	1.39 (0.90-2.17)	0.80 (0.48-1.32)	0.89
Musacea	≤8/y	<2/mo	<1/wk	≥1/wk	
No. cases/controls	96/252	90/253	78/229	114/336	
OR (95% CI)*	1.00	1.16 (0.74-1.83)	0.99 (0.62-1.56)	1.27 (0.82-1.98)	0.32
OR (95% CI)†	1.00	1.19 (0.75-1.87)	0.99 (0.62-1.57)	1.29 (0.83-2.01)	0.39
Nymphaeaceae	0	>0			
No. cases/controls	78/157	300/913			
OR (95% CI)*	1.00	0.61 (0.41-0.92)			0.02
OR (95% CI)†	1.00	0.61 (0.40-0.91)			0.02
Rosaceae	≤4.1/mo	<1.9/wk	<3.6/wk	≥3.6/wk	
No. cases/controls	102/265	74/270	97/269	105/266	
OR (95% CI)*	1.00	0.67 (0.42-1.10)	0.63 (0.39-1.01)	0.70 (0.42-1.18)	0.18
OR (95% CI)†	1.00	0.66 (0.40-1.07)	0.60 (0.37-0.97)	0.67 (0.40-1.13)	0.14
Rutaceae	≤1.1/mo	<2.9/mo	<1/wk	≥1/wk	
No. cases/controls	103/282	102/348	58/175	115/265	
OR (95% CI)*	1.00	0.94 (0.61-1.45)	0.84 (0.50-1.42)	0.91 (0.58-1.43)	0.64
OR (95% CI)†	1.00	0.93 (0.60-1.44)	0.83 (0.48-1.40)	0.91 (0.58-1.43)	0.64
Sapindaceae	0	>0			
No. cases/controls	83/138	295/932			
OR (95% CI)*	1.00	0.87 (0.58-1.30)			0.49
OR (95% CI)†	1.00	0.86 (0.58-1.29)			0.46
Solanaceae	≤1.5/wk	<2.5/wk	<3.5/wk	≥3.5/wk	
No. cases/controls	134/268	88/264	81/273	75/265	
OR (95% CI)*	1.00	0.94 (0.60-1.45)	1.03 (0.66-1.62)	0.79 (0.49-1.28)	0.46
OR (95% CI)†	1.00	0.94 (0.61-1.45)	1.05 (0.67-1.64)	0.82 (0.50-1.32)	0.54
Umbelliferae	≤1.1/mo	<1.9/mo	<3.3/mo	>3.3/mo	
No. cases/controls	83/256	92/273	90/274	113/267	
OR (95% CI)*	1.00	1.40 (0.88-2.24)	1.63 (1.02-2.60)	1.79 (1.11-2.90)	0.02
OR (95% CI)†	1.00	1.43 (0.89-2.29)	1.64 (1.02-2.63)	1.83 (1.13-2.97)	0.01
Vitaceae	0	>0			
No. cases/controls	33/42	345/1028			
OR (95% CI)*	1.00	0.94 (0.49-1.78)			0.84
OR (95% CI)†	1.00	0.93 (0.49-1.77)			0.83
Zingiberaceae	≤4/wk	<5/wk	<1/d	≥1/d	
No. cases/controls	155/264	62/219	32/156	129/431	
OR (95% CI)*	1.00	0.96 (0.60-1.56)	1.51 (0.83-2.74)	1.06 (0.73-1.53)	0.64
OR (95% CI)†	1.00	0.97 (0.60-1.58)	1.52 (0.84-2.76)	1.05 (0.73-1.52)	0.66

NOTE: All analyses stratified by year of interview (1995-1996, 1997, 1998-1999, and 2000-2001), using conditional logistic regression.
*Adjusted for age and total fruit and vegetable intake.
† Adjusted for age, total fruit and vegetable intake, and breast-feeding.

are known to regulate cell growth, differentiation and apoptosis (48). In several tumor cell lines and particularly in human colon cancer cell lines, sphingolipids have been shown to be growth inhibitory and induce apoptosis (49, 50). Eggs are also an excellent source of certain amino acids, may contain high levels of lutein and zeaxanthin and provide small amounts of both omega-3 and omega-6 fatty acids. However, the levels of these nutrients vary according to the diet of the fowl.

The nonfat portion of sesame oil contains a number of lignans including sesamin, episesamin, sesaminol, sesamolin, and primarily sesamol (51). These lignans have been hypothesized to reduce cancer risk through interfering with the expression of a number of enzymes involved in the desaturation and elongation of omega-6 fatty acids (primarily Δ-5 desaturase) and in *de novo* fatty acid synthesis (sterol regulatory element binding protein-1; refs. 51-53). Our finding of a 40% reduction in breast cancer risk among women using sesame oil is consistent with this proposed role for sesame oil in cancer prevention. However, these results must be interpreted cautiously due to the imprecision of our measure of oil use and the small variation in consumption of sesame oil in the study population.

Botanical Groupings. Findings from studies that have attempted to evaluate specific phytochemicals, such as the carotenoids and vitamin C, and breast cancer risk are not as consistent as those for total fruit and vegetable consumption (23), suggesting that other unmeasured phytochemicals may be responsible for the protective effect of fruits and vegetables. Many specific phytochemicals are found in high levels in all or many of the members of the same botanical family (e.g., indole-3-carbinol in cruciferous vegetables). Therefore, evaluating the effects of foods categorized by botanical family (see Appendix B) may provide an insight into potentially active but currently undescribed phytochemicals.

Whereas we report several significant associations between individual botanical groupings and breast cancer risk, the majority of these were for botanical groups of which there was very little variation in intake (Araliaceae, Nymphaeaceae, and Ebenaceae). Thus, although intriguing, they must be viewed cautiously until confirmed in other studies. However, among the botanical groupings with adequate variation in intake, we report a significant positive association between Umbelliferae (carrots and celery) and risk of breast cancer.

Umbelliferae (also known as Apiaceae) are a source of furanocoumarins. These compounds are potent biological agents that can generate reactive oxygen species and modulate cytochrome *P*450 activities (54-56). The majority of work evaluating the effect of furanocoumarins on breast cancer risk has been carried out in *in vitro* or animal systems and has focused on inhibition of CYP1 family enzymes. The implications of our finding of a positive association between Umbelliferae and breast cancer risk are unclear but may reflect the potential dual nature of these compounds (e.g., both anticarcinogenic and procarcinogenic).

Overall, no single botanical grouping explained the protective effect of total fruit and vegetable consumption, suggesting that this inverse association may be due to either a different unmeasured phytochemical, or most likely the effect of a ''phytochemical cocktail'' that would result from the regular consumption of a variety of fruits and vegetables.

A limitation to this study is that the method of portion size estimation does not take into account possible individual variation. Whereas assessment of portion size may improve the precision of the estimate of intake, it has been shown that frequency of intake, not portion size, explains most of the variation in intake (21). Additionally, any misclassification would likely be similar for cases and controls, and only bias OR values toward the null. A primary limitation of case-control studies is the potential for measurement error. Subjects' responses may be altered by knowledge of their disease, or they may simply have difficulty recalling their exposure (dietary intake, in this case) accurately. Whereas these concerns are still important to consider, in the current study, we attempted to minimize the potential for bias through conducting interviews before a woman's breast biopsy.

To further address the reliability and validity of our FFQ, we compared the reported intake of our control women to that reported by women in a validation study conducted by Shu et al. (57). In that study, 200 women completed twenty-four 24-hour recalls over the course of 12 months. Our reported intake of total calories and fat were higher than that calculated

Appendix A. List of foods assessed within each food group, Shanghai nutrition and breast disease study, 1995 to 2000

- Total fruit and vegetable
- *Fruit*
  - Apples
  - Pears
  - Oranges or tangerines
  - Lychee
  - Bananas
  - Peaches
  - Persimmons
  - Pineapple
  - Grapes
  - Apricots
  - Watermelon
- *Vegetables*
  - Bok choy
  - Spinach
  - Cabbage
  - Chinese cabbage
  - Watercress
  - Broccoli
  - Chinese broccoli
  - Green asparagus
  - Cauliflower
  - Celery
  - Eggplant
  - Wild rice stem
  - Winter squash
  - Lettuce
  - Yellow sweet potatoes or yams
  - Other potatoes
  - Wax gourd
  - Gherkin (cucumber)
  - Carrots
  - Pumpkin
  - Mushrooms
  - Red or green pepper
  - Tomato
  - Bamboo shoots
  - Radish or turnips
  - Lotus rhizomes
  - Taro root
  - Corn
  - Onions and chives
  - Garlic stalk
  - Seaweed
- *Preserved vegetables*
  - Salted mustard greens
  - Other salted vegetables
- *Total soyfoods*
  - ***Soy foods***
  - Soy bean milk
  - Fried bean curd puff
  - Fresh bean curd
  - Other soybean foods
  - Soybeans or szuki beans
  - *Fermented bean curd*
- Other legumes
  - Red pea or green bean soup
  - Peanuts
  - Peanut butter
  - Mung beans
  - Other dried beans
  - Mung bean sprouts
  - String beans
  - Hyacinth beans
  - Peas or cow peas
  - Green or kedney beans
  - Freash fava beans
- Total meat
  - *Red meat*
  - Pork
  - Pork chops
  - Spareribs
  - Pig trotters
  - Fresh pork, fat and lean
  - Ham
  - Pork liver
  - Beef
  - Other red meats
  - Organ meat (except liver)
  - Lamb or mutton
- *Poultry*
  - Chicken
  - Duck or goose
- *Eggs*
  - *Cured meat and fish*
  - Salted fish
  - Salted pork
- *Unsalted fish*
  - Hair tail or yellow crooker
  - Carp
  - Rice field or Japanese eel
  - Canned fish
- *Shellfish*
  - Shrimp
  - Crab
  - Snail
  - Conch
  - Squid
  - Sea cucumber
  - Oyster
  - Mussels
  - Clams
- *Dairy*
  - Fresh whole milk
  - Fresh nonfat milk
  - Ice cream
  - Powdered milk
- *Rice*
- Other grains
  - Steamed bread, unfilled
  - Cakes and pastries
  - Cookies
  - Wheat gluten
  - Noodles
- Sesame oil
- Soybean oil
- Fried foods
  - Fried bean curd puff
  - Fried chicken
  - Breaded fried vegetables
  - Breaded fried fish
  - Breaded fired pork chop
  - Deep fried egg roll
  - Deep fried dumplings
  - Deep fried dough stick
  - Pan fried pizza

Appendix B. List of foods assessed within each botanical family, Shanghai nutrition and breast disease study, 1995 to 2000

- Araliaceae
  - Fresh ginseng
  - White ginseng powder or extract
  - Red ginseng powder or extract
- Compositae
  - Sunflower Seeds
  - Lettuce
- Convolvulaceae/Dioscoreaceae
  - Yellow sweet potatoes
  - Yam
- Cruciferae
  - Bok choy
  - Cabbage
  - Chinese cabbage
  - Watercress
  - Broccoli
  - Chinese broccoli
  - Cauliflower
  - Radish or turnips
- Cucurbitaceae
  - Winter squash
  - Wax gourd
  - Gherkin (cucumber)
  - Pumpkin
  - Watermelon
- Ebenacea
  - Persimmon
- Laminarlaceae
  - Seaweed
- Leguminosae
  - Peanuts
  - Peanut butter
  - Soybean milk
  - Fried bean curd puff
  - Fresh bean curd
  - String beans
  - Soybeans
  - Mung beans
  - Szuki beans
  - Green or kidney beans
  - Fresh fava beans
  - Hyacinth beans
  - Peas or cow peas
  - Mung bean sprouts
  - Red pea or green bean soup
  - Other soybean foods
- Liliaceae
  - Asparagus
  - Garlic
  - Garlic stalk
  - Onions
  - Chives
  - Scallions
  - Chinese chives
- Rosaceae
  - Apples
  - Pears
  - Peaches
  - Apricots
- Musaceae
  - Banana
- Nymphacea
  - Lotus rhizomes
- Rutaceae
  - Oranges
  - Tangerines
- Sapindaceae
  - Lychee salanaceae
  - Eggplant
  - Other potato
  - Tomato
  - Hot pepper
  - Red or green pepper
- Umbelliferae
  - Celery
  - Carrots
- Vitaceae
  - Grapes
- Zingiberaceae
  - Ginger root

from the 24-hour recalls, but total protein was within the 25th to 75th percentile and total carbohydrates were virtually identical. The estimated median gram intakes of eggs, vegetables, fruits and rice determined using our FFQ were quite similar to those reported from the 24-hour recalls, whereas intake of red meat was lower but still within the 25th to 75th percentile. The internal validity of our FFQ assessment of soy was assessed by Frankenfeld et al. (58) by comparing reported soy intake to isoflavone concentrations in plasma samples obtained from women within 1 week of completing the FFQ. A significant linear trend was observed between serum daidzein and genistein concentrations and increasing categories of soy consumption, suggesting that our FFQ provides a reasonably good assessment of soy intake.

Whereas the median reported intake in our study population may be similar to that reported in other validation studies, it is possible that the range of intake is narrow and thereby may limit our ability to identify an association should one exist. However, when the range of intake in our study was compared with that reported in a similar study of breast cancer risk in Western women (26), the range of intake was quite similar with the exception that there was an overall higher consumption of vegetables and soyfoods among the Chinese women.

In summary, a strong association between consumption of fruits and vegetables and breast cancer risk was observed. No single botanical group explained this association. Overall, the results of this study provide further support for the protective role of a diet rich in a wide variety fruits and vegetables against breast cancer.

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