

## Exercise, Tea Consumption, and Depression Among Breast Cancer Survivors

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### ABSTRACT

#### Purpose

To examine the association of lifestyle factors and supplement use with depression among breast cancer survivors.

#### Patients and Methods

In a population-based cohort study conducted between April 2002 and December 2006 in Shanghai, China, a total of 1,399 women who were diagnosed with stage 0 to III breast cancer completed 6-month and 18-month postdiagnosis, in-person interviews. Information on sociodemographic, clinical, and lifestyle factors were collected through the interviews and through review of medical charts at approximately 6 months postdiagnosis. A metabolic equivalent (MET) score was calculated from reported exercise activities. Quality of life (QOL) was evaluated by the Medical Outcomes Short Form-36 Health Survey at 6 months postdiagnosis. Depressive symptoms were measured by using a 20-item Center for Epidemiological Studies–Depression Scale at approximately 18 months postdiagnosis.

#### Results

Overall, 26% of women reported depressive symptoms and 13% met the criteria of clinical depression at 18 months postdiagnosis. Women with a higher exercise level (ie,  $\geq 8.3$  MET h/wk) were less likely to have depression than nonexercisers; the multivariate adjusted odds ratios (ORs) were 0.71 (95% CI, 0.47 to 1.07) for mild depression and 0.56 (95% CI, 0.35 to 0.88) for clinical depression in analyses controlled for sociodemographic and clinical factors and baseline QOL. Women who increased their exercise level had lower risk for depression. Regular tea consumption (ie,  $> 100$  g dried tea leaves/mo) was inversely associated with overall depression (OR, 0.39; 95% CI, 0.19 to 0.84). No associations were found for dietary intake or supplement use with depression.

#### Conclusion

Regular exercise participation and tea consumption may play an important role in the prevention of depression among breast cancer survivors.

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### INTRODUCTION

With early detection and improved treatment, the numbers of patients with breast cancer and survivors have been increasing worldwide.<sup>1,2</sup> Diagnosis and adjuvant treatments for breast cancer can cause psychological distress. As a result, depression is a major health issue among patients with and survivors of breast cancer.<sup>3,4</sup> Although estimates vary widely, the prevalence of depression has been reported to be as high as 55%, usually in the first 6 months after breast cancer diagnosis.<sup>4-10</sup> Depression may reduce quality of life (QOL),<sup>3,11,12</sup> may affect the length of hospital stays and therapy compliance,<sup>13-15</sup> and may be a prognostic factor for breast cancer survival.<sup>7,16-18</sup>

Lifestyle factors, such as physical activity, are related to a reduced risk of developing depression in the general population.<sup>19,20</sup> However, these associations have not been well documented among survivors of breast cancer. A few cross-sectional studies have examined the relation between physical activity and depression in patients with breast cancer, with inconsistent results.<sup>6,21-24</sup> Several clinical trials have produced limited and mixed results on the effect of lifestyle intervention on depression.<sup>25-28</sup> It has been suggested in experimental studies that tea and complementary and alternative medicines (CAMs) may have antidepressant properties.<sup>29-32</sup> The associations of dietary intakes and tea consumption with depression, however, have not been well evaluated. Furthermore, although CAM use among breast cancer survivors is

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highly prevalent,<sup>33,34</sup> little is known about its effect on depression among these women.

Here, we report a systematic evaluation of the association of lifestyle factors and CAM use immediately after cancer diagnosis with depression at 18 months postdiagnosis among breast cancer survivors.

## PATIENTS AND METHODS

### Participants

Study participants were women who were diagnosed with a primary breast cancer and enrolled in the Shanghai Breast Cancer Survival Study (SBCSS), a population-based cohort study in Shanghai, China.<sup>35,36</sup> Through the population-based Shanghai Cancer Registry, 6,299 women were identified approximately 6 months after cancer diagnosis, and 5042 were enrolled in the study (participation rate, 80.0%) between April 1, 2002 and December 31, 2006 (baseline interview). Study participants were observed through in-person interviews, administered approximately 18 months postdiagnosis. Of these participants, 1,400 were invited to participate in a depression survey administered as part of the 18-month follow-up. Sociodemographic and clinical features were similar between women who were enrolled on the depression study and the whole cohort of women (data not shown). The SBCSS was approved by the institutional review boards of all institutions involved in the study, and written, informed consent was obtained from all participants.

### Procedures and Measures

Structured questionnaires were administered in person at the baseline interview by trained interviewers, who collected information on cancer diagnosis and cancer-related treatments, sociodemographics, comorbidity, menstrual and reproductive history, lifestyles, CAM use, weight history, and QOL. Anthropometric measurements were taken according to a standard protocol. Self-reported weight at diagnosis was also collected through the in-person interview. Weight was measured at the 18-month postdiagnosis survey. Body mass index (BMI) at baseline and weight change during the 18-month postdiagnosis period were calculated.

**Clinical factors.** Information on TNM stage at diagnosis, estrogen receptor (ER) and progesterone receptor (PR) statuses, type of surgery, chemotherapy, radiotherapy, immunotherapy, and tamoxifen use were collected at baseline. Medical charts were reviewed to verify diagnosis, treatment, and disease stage information. ER and PR statuses were included in the analyses in the following joint categories: ER-positive/PR-positive (ie, receptor-positive), ER-negative/PR-negative (ie, receptor-negative), and ER-negative/PR-positive or ER-positive/PR-negative (ie, mixed). A Charlson comorbidity index was created for each participant on the basis of a validated comorbidity scoring system<sup>37</sup> and the diagnostic codes from the International Classification of Disease (ICD-9).<sup>38</sup>

**Lifestyle factors.** By using a validated exercise questionnaire,<sup>39</sup> information on exercise frequency and duration during the first 6 months postdiagnosis was obtained for up to four types of exercise activity at baseline. On the basis of the method proposed by Ainsworth et al,<sup>40</sup> each activity was assigned a metabolic equivalent (MET) score to represent energy expenditure from exercise. The MET score for each activity was derived from the hours per week (MET h/wk) the participant reported engaging in that activity multiplied by the MET score assigned to the activity.<sup>40</sup> The values from individual activities were summed to derive a total exercise-related MET score. At the 18-month follow-up interview, study participants reported their exercise participation since the baseline interview (ie, for the 12-month period between 6 months postdiagnosis and 18 months postdiagnosis) by using the same exercise questionnaire.

Habitual dietary intake at baseline was assessed by using an abbreviated, 29-item food frequency questionnaire that was specifically intended to measure the intake of soy food, cruciferous vegetables, and meat. Details about the full-scale dietary assessment questionnaire have been described elsewhere.<sup>41</sup>

At the baseline interview, participants were asked whether they regularly drank tea and at what age they started regularly drinking tea, and this was followed by questions on the type and the amount of tea (in dry weight of dried

tea leaves) consumed per month during the year before the interview as well as current status of tea consumption. Those who were former tea drinkers were additionally asked about the age at which they stopped regularly drinking tea.

Information about other lifestyle factors, including alcohol consumption and cigarette smoking, was also obtained at baseline. Information on CAM use, including Chinese herbal medicine and supplements, was also collected.

**QOL.** The Medical Outcomes Short Form-36 Health Survey (SF-36) was administered at the baseline interview. The SF-36 is a generic health outcome measure, which includes 36 items across eight scales. Total QOL and scale scores range from 0 to 100, and higher scores represent better QOL. The SF-36 mental health index scale has been used to screen for mood disorders in the general population<sup>42</sup> and for depression among outpatients with HIV.<sup>43</sup>

**Depression.** At the 18-month postdiagnosis interview, the 20-item Center for Epidemiological Studies Depression Scale (CES-D) was used to assess the depressive symptoms experienced by participants in the week before the interview.<sup>44</sup> Individual items on the CES-D are scored on a 4-point scale, and the total score ranges from 0 to 60; a higher score indicates more depressive symptoms. A total score of 0 to 9 suggests that the patient is not depressed (without depression), a score of 10 to 15 suggests mild depression, and a score  $\geq 16$  indicates clinical depression.<sup>44</sup> The Chinese version of the CES-D has been validated.<sup>45</sup>

### Statistical Methods

The main outcome measures were mild depression and clinical depression. Of the 1,400 participants, one patient had stage IV disease and was excluded from the analyses to address concern that depression may be common among women with stage IV breast cancer. Duration of exercise and exercise-related MET scores were categorized by using the medians as the cutoff points among exercisers, and nonexercisers served as the reference. Type of exercise was examined for women who had ever participated in a specific exercise. Change in exercise level between the 6- and 18-month postdiagnosis interviews also was evaluated. Dietary intakes were categorized by quartile distribution. Tea drinkers were grouped by using the median amounts of dried tea leaves consumed per month (g/mo) and years of tea drinking as the cut points, and participants without tea consumption were treated as the reference.

Analyses of variance (ANOVA) and  $\chi^2$  tests were conducted to evaluate differences in covariates on either a continuous or discrete scale across depression status. For ordinal variables (eg, education), Kendall's  $\tau$  test was applied to assess the differences. Multinomial logistic regression models were conducted to assess associations of lifestyle factors and CAM use with mild and clinical depression; women without depression served as the reference. Odds ratios (ORs) and 95% CIs were adjusted for age at diagnosis, education, income, marital status, comorbidity, menopausal symptoms, the SF-36 mental health index score, relapse/metastasis, and radiotherapy. We also evaluated mild or clinical depression as a single group in the multivariate logistic regression analyses to examine the association of lifestyle factors with overall depression.

Tests for trend were performed by entering the categorical variables as continuous parameters in the models. Because many of the study variables were intercorrelated, we did not implement adjustments for multiple comparisons. Analyses stratified by QOL score (SF-36 mental health index scale) were conducted. All tests were performed by using Statistical Analysis Software (SAS, version 9.1; SAS Institute, Cary, NC). The significance levels were set at  $P < .05$  for two-sided analyses.

## RESULTS

Table 1 presents the baseline sociodemographic and clinical characteristics of the 1,399 participants. The mean age at cancer diagnosis was 53.7 years (standard deviation, 9.8 years). Approximately two thirds of women regularly participated in exercise, and 13% drank tea regularly after diagnosis (90% drank green tea). Overall, 26% of women reported depressive symptoms at 18 months postdiagnosis,

Lifestyle and Depression in Breast Cancer

**Table 1.** Baseline Sociodemographic, Clinical, and Lifestyle Characteristics of the Study Participants

Characteristic	Total (N = 1,399)	Depression Status			P*
		No Depression (n = 1,036)	Mild Depression (n = 187)	Clinical Depression (n = 176)	
Age at diagnosis, years					.038
Mean	53.7	53.4	54.3	55.2	
SD	9.8	9.7	10.2	9.8	
Education level					.006†
< High school	44.3	42.3	44.9	55.1	
High school	39.0	40.2	37.4	33.5	
> High school	16.7	17.5	17.7	11.4	
Income, yuan/mo/capita					< .001†
< 1,000	46.1	41.3	57.2	62.5	
1,000-1,999	39.5	41.7	35.3	31.3	
≥ 2,000	14.4	17.0	7.5	6.3	
Marital status					.006
Married	88.1	90.1	82.4	83.0	
Widowed	7.9	6.5	12.3	11.9	
Divorced/separated/single	3.9	3.5	5.3	5.1	
Postmenopausal	52.9	52.5	54.0	54.0	.888
Menopausal symptoms	82.6	79.3	89.8	93.8	< .001
Charlson comorbidity index ≥ 1	22.4	20.1	27.3	30.7	< .001†
Total QOL score					< .001
Mean	56.4	60.3	49.2	41.1	
SD	16.4	15.0	15.0	13.8	
QOL score in MH domain					< .001
Mean	64.1	69.7	52.8	43.3	
SD	23.6	20.6	24.8	23.1	
Mastectomy	94.3	93.5	96.3	96.6	.124
Body mass index, kg/m <sup>2</sup>					.206
Mean	24.0	24.1	23.6	24.1	
SD	3.5	3.4	3.6	4.0	
Weight change‡					.775
Mean	1.6	1.7	1.5	1.8	
SD	4.4	4.4	4.2	4.8	
Exercise participation	62.3	64.6	57.2	54.0	.009
Tea consumption	13.1	14.7	7.5	9.7	.010
Cigarette smoking	3.6	3.8	2.7	3.4	.755
Alcohol consumption	4.4	4.2	3.7	6.3	.409
Tamoxifen use	47.4	47.2	50.3	45.5	.642
Received chemotherapy	90.9	91.1	89.8	91.5	.829
Received radiotherapy	32.0	34.2	28.9	22.2	.004
Received immunotherapy	15.9	15.4	14.4	19.9	.272
ER/PR status					.489§
Positive	50.5	49.2	56.2	52.3	
Negative	27.6	28.5	23.5	26.7	
Mixed	20.5	20.9	18.7	20.5	
Unknown	1.4	1.5	1.6	0.6	
TNM stage					.454¶
0-I	40.7	41.6	40.1	36.4	
IIA	32.6	31.8	30.5	39.8	
IIB	13.2	13.6	15.0	9.1	
III	8.7	8.5	8.6	10.2	
Unknown	4.7	4.5	5.9	4.6	

Abbreviations: SD, standard deviation; QOL, quality of life; MH, mental health; ER, estrogen receptor; PR, progesterone receptor.

\*For tests of differences between women without depression, with mild depression, and with clinical depression. ANOVA test was used for continuous variables (eg, age at diagnosis);  $\chi^2$  test was used for categoric variables.

†Kendall  $\tau$  test was applied.

‡Weight change from diagnosis to 18 months postdiagnosis.

§For  $\chi^2$  test, unknown group was excluded.

¶For Kendall  $\tau$  test, unknown group was excluded.

**Table 2.** Association of Depression With Exercise Among Breast Cancer Survivors

Characteristic	Depression Status									
	None (No. of patients)	Mild			Clinical			Overall		
		No.	OR	95% CI	No.	OR	95% CI	No.	OR	95% CI
<b>Exercise participation</b>										
No	367	80	1.00		81	1.00		161	1.00	
Yes	669	107	0.81	0.58 to 1.13	95	0.76	0.53 to 1.08	202	0.79	0.60 to 1.03
<b>Duration of exercise h/wk</b>										
No	367	80	1.00		81	1.00		161	1.00	
< 2	318	59	0.89	0.60 to 1.31	59	0.94	0.63 to 1.40	118	0.91	0.67 to 1.25
≥ 2	351	48	0.72	0.48 to 1.08	36	0.57	0.36 to 0.90	84	0.65	0.47 to 0.91
<i>P</i> for trend			.114			.021			.015	
<b>Exercise-related MET score, MET h/wk</b>										
No	367	80	1.00		81	1.00		161	1.00	
< 8.3	316	59	0.90	0.61 to 1.33	59	0.95	0.64 to 1.43	118	0.93	0.68 to 1.27
≥ 8.3	353	48	0.71	0.47 to 1.07	36	0.56	0.35 to 0.88	84	0.64	0.46 to 0.90
<i>P</i> for trend			.103			.018			.012	
<b>Type of exercise*</b>										
No exercise	367	80	1.00		81	1.00		161	1.00	
Walking	475	74	0.80	0.56 to 1.16	61	0.71	0.48 to 1.05	135	0.76	0.57 to 1.03
Gymnastics	238	44	0.95	0.62 to 1.46	33	0.76	0.47 to 1.23	77	0.87	0.61 to 1.24
Taichi/Qigong	47	7	0.67	0.28 to 1.63	3	0.30	0.09 to 1.08	10	0.50	0.23 to 1.10
Jogging/dancing	31	7	1.14	0.46 to 2.85	3	0.49	0.14 to 1.76	10	0.83	0.37 to 1.86
<b>Exercise change†</b>										
No exercise	137	41	1.00		35	1.00		76	1.00	
Started exercising	230	39	0.57	0.34 to 0.95	46	0.79	0.46 to 1.36	85	0.66	0.43 to 1.01
Quit exercising	106	17	0.66	0.34 to 1.27	22	1.09	0.56 to 2.12	39	0.84	0.50 to 1.40
Maintained low exercise level‡	90	14	0.57	0.29 to 1.15	22	1.17	0.60 to 2.29	36	0.82	0.48 to 1.40
Increased exercise level§	201	38	0.60	0.36 to 1.02	27	0.54	0.29 to 0.98	65	0.58	0.37 to 0.90
Decreased exercise level	40	6	0.56	0.21 to 1.48	5	0.58	0.19 to 1.77	11	0.57	0.25 to 1.29
Maintained high exercise level¶	232	32	0.54	0.31 to 0.92	19	0.40	0.21 to 0.76	51	0.48	0.30 to 0.76

NOTE. Patients without depression served as the reference. Analysis was adjusted for age at diagnosis, education, income, marital status, comorbidity, tea consumption, menopausal symptoms, relapse/metastasis, radiotherapy, and quality of life (according to short-form 36-item mental health index scale score). The number of women participating in each type of exercise does not add up to the total number of exercisers because some women participated in multiple types of exercise.

Abbreviations: OR, odds ratio; MET, metabolic equivalent; h, hour; wk, week.

\*Patients who ever participated in a specific type of exercise (eg, walking) were compared with nonexercisers.

†Exercise change from baseline survey (approximately 6 months postdiagnosis) to follow-up survey (approximately 18 months postdiagnosis).

‡Exercise level with exercise-related MET score < 8.3 MET h/wk.

§Exercise level change from exercise-related MET score < 8.3 MET h/wk to ≥ 8.3 MET h/wk.

||Exercise level change from exercise-related MET score ≥ 8.3 MET h/wk to < 8.3 MET h/wk.

¶Exercise level with exercise-related MET score ≥ 8.3 MET h/wk.

13.4% had mild depression, and 12.6% had clinical depression. Depressed women were older at diagnosis and had lower QOL at baseline. Women who had a lower education level, had lower income, were widowed or divorced/separated/single, had menopausal symptoms, had comorbidity, had a lower rate of exercise participation, did not consume tea, or did not receive radiotherapy were more likely to have depression.

Table 2 presents levels of exercise duration and exercise-related energy expenditure, both of which were significantly and inversely associated with clinical and overall depression (all  $P_{\text{trend}} < .05$ ). Longer exercise duration ( $\geq 2$  h/wk) was associated with adjusted ORs of 0.72 (95% CI, 0.48 to 1.08) for mild depression, 0.57 (95% CI, 0.36 to 0.90) for clinical depression, and 0.65 (95% CI, 0.47 to 0.91) for overall depression when compared with no exercise. Similarly, higher exercise-related MET scores ( $\geq 8.3$  MET h/wk) were associated with ORs of 0.71 (95% CI, 0.47 to 1.07) for mild depression, 0.56 (95% CI, 0.35 to 0.88) for clinical depression, and 0.64 (95% CI, 0.46 to 0.90) for overall depression. All types of exercise decreased the risk for clinical

depression. Women who increased their exercise level during the follow-up period had a 42% reduced risk for overall depression (OR, 0.58; 95% CI, 0.37 to 0.90). Similarly, women with a consistently higher postdiagnosis exercise level also had the lowest risk for depression (OR, 0.48; 95% CI, 0.30 to 0.76). We did not find that quitting exercise or decreasing exercise levels during the follow-up period was significantly related to occurrence of depression, although these analyses were based on few women.

As shown in Table 3, tea consumption after diagnosis was inversely associated with the risk for mild depression (OR, 0.54; 95% CI, 0.30 to 0.98), clinical depression (OR 0.76; 95% CI, 0.43 to 1.35), and overall depression (OR, 0.64; 95% CI, 0.41 to 0.99). Lifetime tea consumption was also inversely related to depression.

Dietary intakes of meat, cruciferous vegetables, and soy foods were not significantly related to depression (data not shown). Alcohol consumption, cigarette smoking, Chinese herbal medicine use, and supplement use were not significantly associated with depression (Table 4).

**Table 3.** Association of Tea Consumption With Depression Among Breast Cancer Survivors

Characteristic	Depression Status									
	None (No. of patients)	Mild			Clinical			Overall		
		No.	OR	95% CI	No.	OR	95% CI	No.	OR	95% CI
Tea consumption postdiagnosis										
No	884	173	1.00		159	1.00		332	1.00	
Yes	152	14	0.54	0.30 to 0.98	17	0.76	0.43 to 1.35	31	0.64	0.41 to 0.99
Tea consumption postdiagnosis										
Never	751	156	1.00		145	1.00		301	1.00	
Former	133	17	0.65	0.37 to 1.14	14	0.63	0.34 to 1.16	31	0.64	0.41 to 1.00
Current	152	14	0.51	0.28 to 0.93	17	0.72	0.40 to 1.28	31	0.60	0.39 to 0.95
<i>P</i> for trend			.013			.127			.008	
Tea consumption amount postdiagnosis										
No	884	173	1.00		159	1.00		332	1.00	
Yes										
≤ 100 g/mo	83	11	0.81	0.41 to 1.59	11	0.91	0.44 to 1.86	22	0.85	0.50 to 1.46
> 100 g/mo	69	3	0.25	0.07 to 0.80	6	0.58	0.23 to 1.45	9	0.39	0.19 to 0.84
<i>P</i> for trend			.017			.256			.018	
Lifetime tea consumption, years										
No	751	156	1.00		145	1.00		301	1.00	
Yes	285	31	0.58	0.38 to 0.89	31	0.67	0.43 to 1.05	62	0.62	0.44 to 0.87
< 18	146	15	0.51	0.28 to 0.91	13	0.48	0.25 to 0.90	28	0.49	0.31 to 0.78
≥ 18	139	16	0.67	0.38 to 1.18	18	0.94	0.53 to 1.68	34	0.78	0.50 to 1.22
<i>P</i> for trend			.037			.289			.036	

NOTE. Patients without depression served as the reference. Adjusted for age at diagnosis, education, income, marital status, exercise, comorbidity, menopausal symptoms, relapse/metastasis, radiotherapy, and quality of life (SF-36 mental health index scale score). Abbreviation: OR, odds ratio.

Additional analyses stratified by baseline QOL (ie, SF-36 mental health index score) suggested that the associations of exercise participation and tea consumption with depression were slightly stronger among women with lower QOL (score < median) than among women with higher QOL (score ≥ median), although the interaction tests were not statistically significant (data not shown). However, these stratified analyses were based on a small number of women with depression, especially for tea consumption.

## DISCUSSION

In this population-based cohort study, we found that women who exercised for ≥ 2 h/wk or whose energy expenditure from exercise was ≥ 8.3 MET h/wk postdiagnosis were less likely to have depression than nonexercisers. Increased exercise level after diagnosis was also related to a reduced prevalence of depression. Furthermore, tea consumption was inversely related to depression. These associations remained significant even after concurrently controlling for sociodemographic and clinical characteristics and baseline QOL.

Depression is a major concern for patients with and survivors of breast cancer.<sup>3,4</sup> Several clinical trials have observed some beneficial effect of short-term lifestyle interventions (ie, exercise) on depression among women with breast cancer.<sup>25-27,46-50</sup> For example, in a study of 24 breast cancer survivors, Segar et al<sup>47</sup> reported that women who participated in a 10-week, mild-to-moderate aerobic exercise program had significantly less depression than nonexercisers. Another clinical trial of 46 patients with early-stage breast cancer found that women who engaged in an individualized, self-paced, home-based walking exercise program throughout radiotherapy reported lower

emotional distress.<sup>50</sup> These clinical trials had small sample sizes but provide preliminary evidence for the effect of exercise intervention on depression in breast cancer.

Few observational studies have investigated the association between exercise and depression among breast cancer survivors, and findings have been inconsistent.<sup>6,21-24</sup> The Women's Healthy Eating and Living (WHEL) study found no association of exercise with depression.<sup>22</sup> Three other small, cross-sectional studies reported that exercise was related to low prevalence of depression.<sup>6,21,24</sup> However, no causal effect can be determined from these studies, given their cross-sectional designs. To our knowledge, our study is the first population-based, cohort study that has evaluated the association of exercise and its change over time with depression among breast cancer survivors.

Exercise may alleviate depressive symptoms through plausible mechanisms, such as improved physical fitness, self-efficacy, and distraction from common symptoms (eg, insomnia, pain) associated with cancer and cancer-related treatments.<sup>51</sup> Conversely, depressed women may be more likely to be introverted and less likely to participate in exercise, raising a concern about possible reverse causation for the observed exercise-depression association. To address this concern, we evaluated this association stratified by the baseline SF-36 mental health index score (an indicator of baseline depression). We found no interaction between exercise and baseline depression. The inverse association persisted after additional adjustment for baseline depression. Furthermore, we found that women who increased or consistently had a higher level of exercise participation postdiagnosis had a significantly reduced risk of depression. However, quitting exercise or reducing exercise level was not related to increased depression. These

**Table 4.** Association of Depression With Smoking, Alcohol Consumption, and the Use of Complementary and Alternative Medicine Among Breast Cancer Survivors

Characteristic	Depression Status									
	None (No. of patients)	Mild			Clinical			Overall		
		No.	OR	95% CI	No.	OR	95% CI	No.	OR	95% CI
Alcohol consumption										
No	993	180	1.00		165	1.00		345	1.00	
Yes	43	7	0.86	0.37 to 2.01	11	1.50	0.70 to 3.19	18	1.14	0.61 to 2.12
Cigarette smoking										
No	997	182	1.00		170	1.00		352	1.00	
Yes	39	5	0.65	0.24 to 1.74	6	0.77	0.29 to 2.03	11	0.71	0.33 to 1.51
Use of Chinese herbal medicine										
No	213	50	1.00		34	1.00		84	1.00	
Yes	823	137	0.71	0.49 to 1.04	142	1.05	0.68 to 1.64	279	0.84	0.61 to 1.16
Total supplement use										
No	239	47	1.00		44	1.00		91	1.00	
Yes	797	140	1.00	0.68 to 1.47	132	1.09	0.72 to 1.65	272	1.04	0.76 to 1.42
Ginseng use										
No	910	162	1.00		160	1.00		322	1.00	
Yes	126	25	1.08	0.66 to 1.76	16	0.67	0.37 to 1.21	41	0.88	0.58 to 1.33
Ganoderma lucidum capsules/sporophyte										
No	361	74	1.00		66	1.00		140	1.00	
Yes	675	113	0.86	0.61 to 1.22	110	1.01	0.70 to 1.47	223	0.93	0.70 to 1.23
Vitamin supplement										
No	718	127	1.00		126	1.00		253	1.00	
Yes	318	60	1.13	0.79 to 1.62	50	1.01	0.68 to 1.50	110	1.08	0.80 to 1.45
Deep sea fish oil pills										
No	1,012	183	1.00		174	1.00		357	1.00	
Yes	24	4	0.81	0.26 to 2.50	2	0.43	0.09 to 2.03	6	0.64	0.24 to 1.72

NOTE. Patients without depression served as the reference. Analysis was adjusted for age at diagnosis, education, income, marital status, exercise, comorbidity, menopausal symptoms, relapse/metastasis, radiotherapy, and quality of life (according to the short-form, 36-item mental health index scale score). Abbreviation: OR, odds ratio.

findings argue against reverse causation as the sole explanation for the exercise-depression association found in our study. However, our observation of a stronger association for mild depression than for clinical depression may suggest a role for reverse causation for the latter, because clinically depressed patients are more likely to change their behaviors. More studies, particularly clinical trials, are needed to evaluate the effect of exercise on depression.

We found the first epidemiologic evidence that tea consumption may be associated with lower risk for depression among breast cancer survivors, although this was not a prespecified hypothesis. The inverse association was independent of other risk factors for depression. Tea is the most common beverage worldwide. Tea and its constituents contain high levels of caffeine and catechin polyphenols, which have demonstrated antioxidant, anticarcinogenic, anti-inflammatory, thermogenic, probiotic, and antimicrobial properties in numerous human, animal, and in vitro studies.<sup>30,52-54</sup> Animal studies have shown an antidepressant effect of tea extract.<sup>29,30</sup> The possible inhibition of monoamine oxidase and catechol-*o*-methyl transferase enzymes by tea extracts has been suggested to be responsible for the antidepressant activity.<sup>29</sup> A recent cross-sectional study has reported that caffeine consumption, either from coffee or tea, reduced the risk of depression in the general population.<sup>55</sup> More studies are needed to confirm the tea-depression association and to investigate the underlying mechanisms.

The association between diet and depression has not been well studied in breast cancer.<sup>6,22,27</sup> Our study found no association be-

tween habitual dietary intake and depression, similar to the findings from the WHEL study.<sup>22</sup> Few studies have examined whether other lifestyle factors (eg, alcohol consumption, cigarette smoking) are related to depression in women with breast cancer.<sup>22,56</sup> A cross-sectional survey of women in the United States with stage I to IIIA breast cancer observed that neither alcohol consumption nor smoking were related to depression.<sup>22</sup> Another study of women with early-stage breast cancer in Denmark found that extensive alcohol consumption ( $\geq 3$  units/d) or smoking ( $\geq 20$  cigarettes/d) was independently associated with depression.<sup>56</sup> In our study, only 4% of women were regular alcohol drinkers ( $\geq 3$  times/d) or smokers ( $\geq 1$  cigarettes/d), and we found a null association of alcohol consumption or smoking with depression. We did not find that CAM use was significantly associated with depression.

Depression is more common among women with low socioeconomic status.<sup>3,56,57</sup> For example, a recent nationwide study in Denmark showed that socioeconomically deprived women with breast cancer were vulnerable to depression.<sup>56</sup> Healthy lifestyles and CAM use have been positively associated with higher socioeconomic status among women with breast cancer.<sup>36</sup> In our study, however, associations of exercise and tea consumption with depression remained significant after adjustment for education and household income. The null association of CAM use and dietary intake also argues against confounding from socioeconomic status as the sole explanation.

When our findings are interpreted, several limitations should be noted. First, our study included only one assessment of depression,

and depression status at baseline was unknown. However, we found that the mental health index score from the QOL assessment administered at baseline was significantly related to depression at 18 months postdiagnosis ( $r = -0.46$ ), which suggests that QOL is a good indicator for depression in our study, as has been shown in other research.<sup>42,43</sup> We adjusted for the baseline SF-36 mental health index score in our analyses. Nevertheless, residual confounding from the presence of depression at baseline cannot be excluded. Follow-up of this study is ongoing and will allow us to evaluate how depression changes over time and to assess the long-term effects of exercise and tea consumption on depression among breast cancer survivors. Second, the prevalence of some specific lifestyle factors in our study population is low, which may have limited our ability to evaluate the influence of these factors on depression or their confounding effect on the tea-depression association. Third, although it is possible that mild depression might be more sensitive to effects of exercise and tea consumption, our study did not have enough power to evaluate differences between mild and clinical depression. Last, although the high percentage of patients who received chemotherapy and radiotherapy in our study is in agreement with common practice in Shanghai, this practice is different from conventional breast cancer treatments in the United States. Thus, our findings may not be directly generalized to patients with breast cancer in the United States or to women without breast cancer.

Most antidepressant drugs currently available are synthetic, nitrogen-bearing compounds that have been shown to have serious adverse effects, such as cardiovascular disease.<sup>32</sup> Modifiable lifestyle behaviors, exercise participation, and tea consumption may offer a promising alternative to pharmacologic intervention. More research on the long-term effects of exercise and tea consumption on occurrence of depression among patients with different treatment modalities is warranted.

#### AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The author(s) indicated no potential conflicts of interest.

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