

Adherence to the World Cancer Research Fund/ American Institute for Cancer Research Guideline Is Associated With Better Health-Related Quality of Life Among Chinese Patients With Breast Cancer

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Abstract

Background: The 2007 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) guideline provides recommendations for cancer prevention among cancer survivors. Limited data have examined whether guideline adherence is related to health-related quality of life (HRQoL) among Chinese patients with breast cancer. **Methods:** An ongoing prospective cohort study involving 1,462 Chinese women with early-stage breast cancer assessed exercise, diet, and body mass index (BMI) at baseline and at 18-months follow-up after diagnosis. Each assessment recorded patient habits within the previous 12 months. HRQoL was evaluated by the EORTC Quality of Life Questionnaire-Core 30 (EORTC QLQ-C30). We first compared the level of adherence to WCRF/AICR recommendations before and after cancer diagnosis. We then examined whether adherence to these recommendations after diagnosis was associated with HRQoL at 18 months. **Results:** The mean adherence score significantly increased from baseline (3.2; SD, 1.1) to 18-month follow-up (3.9; SD, 1.1; $P < .001$). Overall, increasing adherence to the WCRF/AICR guideline was associated with higher scores of global health status/quality of life (QoL; $P_{\text{trend}} = .011$), physical ($P_{\text{trend}} < .001$) and role functioning ($P_{\text{trend}} = .024$), and lower scores for fatigue ($P_{\text{trend}} = .016$), nausea and vomiting ($P_{\text{trend}} < .001$), pain ($P_{\text{trend}} = .004$), dyspnea ($P_{\text{trend}} = .030$), loss of appetite ($P_{\text{trend}} = .007$), and diarrhea ($P_{\text{trend}} = .020$). Patients with cancer who met the BMI recommendation had higher scores for physical functioning ($P = .001$) and lower scores for fatigue ($P = .024$), pain ($P < .001$), and dyspnea ($P = .045$). Adherence to physical activity recommendation was associated with better scores of global health status/QoL ($P < .001$), physical functioning ($P = .003$), fatigue ($P = .002$), pain ($P = .018$), and dyspnea ($P = .021$). Higher adherence to diet recommendation was associated with lower scores of nausea and vomiting ($P_{\text{trend}} = .005$), loss of appetite ($P_{\text{trend}} = .026$), constipation ($P_{\text{trend}} = .040$), and diarrhea ($P_{\text{trend}} = .031$). **Conclusions:** Chinese patients with breast cancer made positive lifestyle changes early after cancer diagnosis. Increased adherence to WCRF/AICR recommendations after cancer diagnosis may improve HRQoL. Our data suggest that Chinese patients with breast cancer should follow the WCRF/AICR guideline to improve overall well-being.

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In Hong Kong, breast cancer is the most common malignancy and the third leading cause of cancer-related mortality among women.¹ The age-standardized incidence rate was 56.7 per 100,000 people in 2011–2015,

and it is estimated that the number will increase to 62.5 per 100,000 people in 2021–2025.² On the contrary, from 1976–2010, the age-standardized mortality rate decreased on an average of 0.02% annually.² The

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combination of increasing breast cancer incidence and improved outcomes has resulted in an expanding population of breast cancer survivors. Both the cancer diagnosis itself and the treatment-related side effects could influence patients' health-related quality of life (HRQoL).³⁻⁵ Improving HRQoL has been an important goal for the long-term management of breast cancer survivors.

There has been a considerable interest in whether lifestyle factors have an impact on HRQoL among breast cancer survivors. Epidemiologic studies have found that lifestyle factors, including maintaining normal body weight, being physically active, and eating a healthy diet, are individually associated with better HRQoL among breast cancer survivors.⁶⁻⁸ A cancer diagnosis has been considered as a "teachable moment," wherein survivors are likely to make lifestyle changes to promote better health outcomes.⁹ However, studies in the United States and Australia have revealed that few patients actually make these changes, and most patients do not adhere to the physical activity or diet recommendations.¹⁰⁻¹³ To date, limited data have compared the changes before and after diagnosis among Chinese patients with breast cancer.

In 2007, the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) issued 8 recommendations regarding diet and physical activity to reduce the risk of cancer, and encouraged cancer survivors to follow those recommendations as well.¹⁴ Several prospective cohort studies have suggested that increased adherence to the WCRF/AICR recommendations could reduce breast cancer risk.¹⁵⁻¹⁹ However, only a few cohort studies have explored whether higher adherence to WCRF/AICR guidelines improves HRQoL or breast cancer outcome. The Iowa Women's Health Study (IWHS) reported that increased adherence to WCRF/AICR recommendations was associated with better HRQoL and lower all-cause mortality.^{20,21}

Our study hypothesized that patients with breast cancer would increase adherence to lifestyle recommendations after cancer diagnosis, and that adherence to a greater number of lifestyle recommendations would be associated with better HRQoL. We first compared the level of adherence to WCRF/AICR recommendations before and after breast cancer diagnosis. We then examined whether adherence to lifestyle behavior recommendations after diagno-

sis was associated with HRQoL among Chinese patients with breast cancer.

Methods

Study Cohort

The Hong Kong NTEC-KWC Breast Cancer Survival Study (HKNKBCSS) is a prospective cohort study designed to investigate the associations between phytoestrogens and other dietary and lifestyle factors and cancer recurrence and mortality. Participants were recruited from 2 regional cancer centers in Hong Kong. Eligible patients had histologically confirmed breast cancer (AJCC stage 0-III), were female, were diagnosed no more than 12 month before study entry, and did not have a prior history of breast or other cancers. The study was approved by the Joint CUHK-NTEC (the Chinese University of Hong Kong–New Territories East Cluster) Clinical Research Ethics Committee of the Chinese University of Hong Kong and the KWC Research Ethics Committee of the Hong Kong Hospital Authority.

Between January 2011 and February 2014, 2,890 Chinese patients with breast cancer were screened. Among 2,096 eligible subjects, 1,462 provided written informed consent and participated in the study (response rate, 70.0%). Among the remaining cases, 513 (24.3%) refused to participate, 18 (0.8%) could not be contacted, 10 (0.5%) refused treatment for breast cancer, and 93 (4.4%) were excluded for anticipated logistical or potential compliance reasons.

According to the study protocol, the consented patients were interviewed at baseline, 18 months, 36 months, and 60 months after breast cancer diagnosis. The same questionnaire was distributed at baseline and subsequent interviews. Clinical information on disease progression and survival status was collected during follow-up. As of March 2016, the 18-month follow-up interview had been completed and included 1,310 of the 1,462 patients enrolled (follow-up rate, 89.6%). The 36- and 60-month interviews have not been conducted as yet.

This study included patients who had completed the baseline and 18-month follow-up assessment. Participants who did not have their weight and height measured ($n=3$), did not complete the questionnaire for HRQoL ($n=3$), or reported implausible dietary intake (ie, energy intake estimates <500

or >4,000 kcal/d; n=4) were excluded, resulting in 1,300 patients for analysis.

Data Collection

Trained interviewers conducted face-to-face interviews. Participants were asked about their habitual dietary intake and physical activity for specific periods: the preceding 12 months before cancer diagnosis at baseline assessment, and the preceding 12 months at the 18-month follow-up assessment after cancer diagnosis.

Information on dietary intake was collected using validated and interviewer-administered food frequency questionnaires,²² which consisted of 109 food items. Participants were asked to report their usual frequency of consumption and the average amount of food intake each time. The average daily intake of nutrients and total energy were calculated according to the China Food Composition Table.²³ Physical activity was measured by a validated modified Chinese Baecke Questionnaire.²⁴ Subjects who performed sports or exercise were asked to specify the activities (up to 2 self-reported sport activities), categorically, and number of hours per week and months of the year they performed the activity.²⁴

Hospital medical records were reviewed to obtain clinical information, including tumor histology, AJCC stage,²⁵ estrogen receptor (ER) and progesterone receptor (PR) statuses, HER2 status, and treatment information (eg, mastectomy or breast-conserving surgery, chemotherapy, radiation therapy, hormone therapy such as tamoxifen and aromatase inhibitors, and anti-HER2 therapy).

At baseline and 18-month follow-up, the self-reported total comorbidity counts included diabetes, hypertension, hyperlipidemia, chronic liver disease, and chronic kidney disease. Anthropometric measurements included body weight, height, and waist and hip circumferences, which were measured according to standard protocols.

Operationalization of the WCRF/AICR Recommendations

The WCRF/AICR has published 8 broad recommendations for cancer prevention.¹⁴ We operationalized the following 6 recommendations for constructing the adherence score: (1) body fat,²⁶ (2) physical activity,²⁷ (3) food and drink that promote weight gain,^{14,28} (4) plant-derived foods, (5) animal-source

foods, and (6) alcohol.¹⁴ The recommendation on preservation, processing, and preparation of foods was not included because of insufficient data. The recommendation to meet nutritional needs through diet alone was excluded because we were unable to ascertain the reasons for supplement use, such as nutrient repletion or general health promotion. The scoring criteria are summarized in Table 1. We calculated the scores of metabolic equivalent task (MET) hours per week by multiplying the activity's corresponding MET value by the time (hours per week) engaged in the activity.²⁷ We then summed the scores of MET hours per week of each activity to calculate the total scores. The energy density cutoff was based on a public health goal included in the WCRF/AICR recommendation that the average energy density of diets should be lower than 125 kcal per 100 g.¹⁴ Average energy density was calculated as energy (kcal) from foods (solid foods, semisolid foods, and liquid foods such as soups) divided by the weight (gram) of those foods.²⁸

The score assigned to each component was 1 when the recommendation was met. The third, fourth, and fifth guidelines included 2 subrecommendations, and the final component score was the average of the 2 subrecommendation scores. Scores for the 6 recommendations (1 for body mass index [BMI], 1 for physical activity, and 4 for dietary intake) were summed as the WCRF/AICR recommendation adherence score (range, 0–6). We further separated the adherence score into 3 components of the WCRF/AICR guideline: BMI (0–1), physical activity (0–1), and diet (0–4). The scores for adherence to the recommendations were calculated using data collected at baseline and 18-months follow-up.

HRQoL Measurement

Quality of life (QoL) of the patients was measured using a validated Chinese version of the EORTC QoL Questionnaire-Core 30 (EORTC QLQ-C30), version 3.0.²⁹ The QLQ-C30 was designed to assess a range of cancer-specific HRQoL issues relevant to a broad spectrum of patients with cancer.³⁰ The QLQ-C30 included a global health and QoL domain, 5 functional domains (physical, role, emotional, cognitive, and social), 3 symptom domains (fatigue, nausea and vomiting, and pain) and 6 single items (dyspnea, insomnia, loss of appetite, constipation,

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Table 1. Operationalization of Adherence to WCRF/AICR Recommendations

WCRF/AICR Recommendation	Personal Recommendations	Operationalization	Scoring
1. Body fat: be as lean as possible without becoming underweight	(1a) Ensure that body weight throughout childhood and adolescent growth projects toward the lower end of the normal BMI range at age 21 years (1b) Maintain body weight within the normal range from age 21 years (1c) Avoid weight gain and increases in waist circumference throughout adulthood	BMI (kg/m ²)	
		18.5≤BMI<23 BMI<18.5 or BMI≥23	1 0
2. Physical activity: be physically active as part of everyday life	(2a) Be moderately physically active, equivalent to brisk walking, for at least 30 minutes every day (2b) As fitness improves, aim for ≥60 minutes of moderate, or for ≥30 minutes of vigorous, physical activity every day (2c) Limit sedentary habits, such as watching television	Physical activity	
		≥10 MET-hour/week <10 MET-hour/week	1 0
		Energy density ^b	
3. Food and drink: limit consumption of energy-dense foods; avoid sugary drinks ^a	(3a) Consume energy-dense foods sparingly (3b) Avoid sugary drinks (3c) Consume “fast foods” sparingly, if at all	<125 kcal per 100 g ≥125 kcal per 100 g	1 0
		Sugar drinks	
		<1 serving per week ≥1 serving per week	1 0
		Nonstarchy vegetables and fruits	
4. Plant-derived foods: eat mostly foods of plant origin ^a	(4a) Eat at least 5 portions/servings (at least 400 g or 14 oz) of a variety of nonstarchy vegetables and fruits every day (4b) Eat relatively unprocessed cereals (grains) and/or pulses (legumes) with every meal (4c) Limit refined starchy foods (4d) Ensure intake of sufficient nonstarchy vegetables, fruits, and pulses (legumes) when starchy roots or tubers are staples	≥5 servings per day <5 servings per day	1 0
		Whole grains and/or legumes	
		≥1 serving per day <1 serving per day	1 0
		Red meat intake	
5. Animal-source foods: limit intake of red meat and avoid processed meat ^a	(5a) If consuming red meat, eat <500 g (18 oz) per week; very little, if any, processed meats	<500 g/wk ≥500 g/wk	1 0
		Processed meat intake	
		<3 g/d ≥3 g/d	1 0
6. Alcohol: limit alcoholic drinks	(6a) If consuming alcoholic drinks, limit consumption to no more than 2 drinks a day for men and 1 drink a day for women	Alcohol intake	
		≤1 drink per day >1 drink per day	1 0
7. Food preservation, processing, preparation: limit consumption of salt; avoid moldy cereals (grains) or pulses (legumes)	(7a) Avoid salt-preserved, salted, or salty foods; preserve foods without using salt (7b) Limit consumption of processed foods with added salt to ensure an intake of <6 g (2.4 g sodium) a day (7c) Do not eat moldy cereals (grains) or pulses (legumes)	Not operationalized	
8. Dietary supplements: strive to meet nutritional needs through diet alone	(8a) Dietary supplements are not recommended for cancer prevention	Not operationalized	

Abbreviations: BMI, body mass index; MET, metabolic equivalent task; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research.

^aThe score for recommendations 3, 4, and 5 was the result of averaging the scores of each subrecommendation.

^bEnergy density was calculated as energy (kcal) from foods (solid foods, semisolid foods, and liquid foods such as soups) divided by the weight (gram) of those foods (kcal per 100 g).

diarrhea, and financial impact). Raw scores were transformed into standard scores ranging from 0 to 100.³¹ High scores on the global and functioning scales indicated good HRQoL, whereas high scores on the symptom scales and items represented a high level of symptoms and/or problems.³¹

Statistical Analyses

Paired Wilcoxon rank test was used to compare the percentage of patients with breast cancer who met each WCRF/AICR recommendation between baseline and 18-month follow-up assessment. Paired *t*-test was performed to compare the overall recommendation adherence score before and after diagnosis.

Patients were categorized into 3 groups according to the tertiles of recommendation adherence score. Characteristics of participants were compared among 3 groups through analysis of variance for continuous data and chi-square test for categorical data. To investigate the association between recommendation adherence score and HRQoL, generalized linear models were used to compare the least-square means by tertiles of adherence score (T1, T2, and T3) and continuous adherence score (eTable 1, available with this article at JNCCN.org). In the multivariate models, we adjusted for breast cancer stage at presentation, as well as age, education level, marital status,

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total number of comorbidities, smoking status, current hormonal therapy, energy intake at 18-month follow-up, and menopausal status.

Additionally, HRQoL was examined in relation to each of the 3 components of adherence score (BMI, physical activity, and diet) (supplemental eTable 2). To evaluate the association of any component with HRQoL beyond the influence from the other 2, we further adjusted the other components in each analysis. Statistical analysis was performed using R software (R version 3.3.2 for Windows; R

Foundation for Statistical Computing, Vienna, Austria) and the differences were considered to be significant at $P < .05$.

Results

Patient Characteristics

A total of 1,300 patients with breast cancer were included. The baseline demographic and clinical characteristics are provided in Table 2. The mean age at the time of 18-month follow-up was 53.7 years;

Table 2. Baseline Demographic and Clinical Characteristics at 18-Month Follow-Up

	All	Recommendation Adherence Score			P Value
		T1 (≤3)	T2 (3.5–4)	T3 (>4)	
N	1,300	374	438	488	
Recommendation adherence score, mean±SD	3.9±1.1	2.5±0.5	3.8±0.25	5.0±0.5	<.001
Age, mean±SD, y	53.7±8.9	52.5±8.9	54.0±9.4	54.3±8.5	.007
Education level, % ^a					.645
High school or below	85.0	85.6	85.8	83.8	
College or above	15.0	14.4	14.2	16.2	
Marital status, %					.092
Married or cohabitation	70.1	65.8	71.2	72.3	
Unmarried, divorced, or widowed	29.9	34.2	28.8	27.7	
Menopausal status, %					.052
Premenopausal	22.8	25.0	24.0	19.3	
Postmenopausal	77.2	74.1	76.0	80.7	
Number of comorbid conditions, %					.007
None	69.0	65.5	64.8	75.4	
1	20.2	21.4	22.4	17.4	
2	8.4	9.9	9.8	5.9	
≥3	2.4	3.2	3.0	1.2	
AJCC stage at diagnosis, % ^a					.122
0	5.6	7.0	5.7	4.5	
I	30.1	28.6	27.6	33.4	
II	45.5	43.6	45.9	46.5	
III	18.8	20.9	20.8	15.6	
Histology ^a					.313
IDC	84.6	83.2	83.6	86.7	
ILC	2.9	2.9	2.3	3.5	
DCIS	5.6	7.0	5.7	4.5	
Other histologies	6.8	7.0	8.4	5.3	
Estrogen receptor status, % ^a					.936
Negative	24.4	24.3	25.6	23.4	
Positive	73.6	73.8	72.6	74.4	
Missing	2.0	1.9	1.8	2.3	
Progesterone receptor status, % ^a					.980
Negative	40.9	39.8	41.6	41.2	
Positive	56.8	57.8	56.4	56.4	
Missing	2.3	2.4	2.1	2.5	
HER2 status, % ^a					.615
Negative	67.0	69.3	66.4	65.8	
Positive	26.5	24.3	25.8	28.9	
Missing	6.5	6.4	7.7	5.3	
Treatment, %					
Surgery	99.9	100	99.9	100	.374
Chemotherapy	76.5	77.5	76.7	75.6	.799
Radiation therapy	71.5	72.5	74.4	68.0	.087
Hormone therapy	74.1	73.3	74.2	74.6	.905
Energy intake, mean±SD, kcal/d	1,361.2±386.8	1,492.9±428.7	1,327.2±377.9	1,338.9±353.6	<.001
Current smoking, %	1.2	2.7	0.7	0.4	.005

Abbreviations: DCIS, ductal carcinoma in situ; IDC, invasive ductal carcinoma; ILC, invasive lobular carcinoma; T, tertile of adherence score; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research.

^aData collected at baseline survey, other data collected at 18-month follow-up survey.

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64.3% had AJCC stage II and III breast cancer. The proportion of tumors with ER, PR, and HER2 positivity was 73.6%, 56.8%, and 26.5%, respectively. At 18-month follow-up, 74.1% of the participants were undergoing adjuvant endocrine therapy.

Adherence to WCRF/AICR Recommendations Before and After Diagnosis

Table 3 shows the proportion of participants who met each recommendation or subrecommendation at baseline and at 18-month follow-up. The proportion of patients who had normal BMI (18.5–22.9 kg/m²) before and after cancer diagnosis was almost the same, at approximately 45%; 68 patients (5.2%) had BMI <18.5 kg/m², and only 7 patients had comorbidities. The proportion of women who met the WCRF/AICR recommendations for physical activity (≥10 MET-hours/week) was very low: only 21.4% met the criteria at prediagnosis, increasing to 33.8% postdiagnosis. However, the proportion of patients who met the recommendations regarding alcohol was very high at both assessments: 98.5% at baseline and 100% at 18-month follow-up. For other dietary components, the proportions of patients who met the recommendation were all increased after diagnosis, ranging from 37.5% to 67.2% at baseline to 40.2% to 85.4% at 18-month follow-up.

Paired Wilcoxon rank test showed that, except for recommendations regarding BMI and intake of whole grain and/or legumes, the proportion of patients who met the other recommendations

or subrecommendations significantly increased at 18-month follow-up (all $P < .001$; Table 3). Before cancer diagnosis, the mean recommendation adherence score was 3.2 (SD, 1.1) in the whole cohort, and 64.2% of the patients had a higher adherence score after diagnosis. At 18-month follow-up, the mean recommendation adherence score significantly increased to 3.9 (SD, 1.1; $P < .001$).

We compared patient characteristics by the tertiles of adherence score (T1, T2, and T3) at 18-month follow-up. Patients who received higher adherence scores were older, had fewer comorbidities, had less energy intake (kcal/d), and showed lower prevalence of current smoking (Table 2).

Association of Recommendation Adherence Score With HRQoL at Follow-Up

The score for HRQoL items ranged from 0 to 100, and a high score for the global health status/QoL or functional domains represented a high QoL or high level of functioning. Increasing adherence to the recommendations (as evaluated by tertile) was associated with significantly higher global health and QoL score (Table 4; 64.25 vs 65.28 vs 67.34, respectively; $P_{\text{trend}} = .011$). The global health and QoL score increased by 1.47 points with every 1-point increment in adherence score. For functional domains, higher adherence to the recommendations had significantly higher scores of physical functioning (89.00 vs 90.30 vs 92.18, respectively; $P_{\text{trend}} < .001$) and role functioning (93.58 vs 93.79 vs 95.78 respec-

Table 3. Adherence to WCRF/AICR Recommendations Before and After Cancer Diagnosis

Operationalization of WCRF/AICR Recommendations	Meet or Not Meet	Scoring	N (%), at Baseline	N (%), at 18-Month Follow-Up	P Value
1. BMI (kg/m ²)	18.5 ≤ BMI < 23	1	572 (44.0)	595 (45.8)	.135
	BMI < 18.5 or BMI ≥ 23	0	728 (56.0)	705 (54.2)	
2. Physical activity	≥ 10 MET-hour/wk	1	278 (21.4)	439 (33.8)	<.001
	< 10 MET-hour/wk	0	1,022 (78.6)	861 (66.2)	
3.1 Energy density ^{a,b}	< 125 kcal per 100 g	1	762 (58.6)	1,094 (85.4)	<.001
	≥ 125 kcal per 100 g	0	538 (41.4)	206 (15.8)	
3.2 Sugar drinks ^b	< 1 serving per week	1	874 (67.2)	1,110 (85.4)	<.001
	≥ 1 serving per week	0	426 (32.8)	190 (14.6)	
4.1 Nonstarchy vegetables and fruits ^b	≥ 5 servings per day	1	698 (53.7)	857 (65.9)	<.001
	< 5 servings per day	0	602 (46.3)	443 (34.1)	
4.2 Whole grains and/or legumes ^b	≥ 1 serving per day	1	488 (37.5)	523 (40.2)	.093
	< 1 serving per day	0	812 (62.5)	777 (59.8)	
5.1 Red meat intake ^b	< 500 g/wk	1	599 (46.1)	867 (66.7)	<.001
	≥ 500 g/wk	0	701 (53.9)	433 (33.3)	
5.2 Processed meat intake ^b	< 3 g/d	1	651 (50.1)	945 (72.7)	<.001
	≥ 3 g/d	0	649 (49.9)	355 (27.3)	
6. Alcohol intake ^b	≤ 1 drink per day	1	1,280 (98.5)	1,300 (100)	<.001
	> 1 drink per day	0	20 (1.5)	0 (0)	

Abbreviations: BMI, body mass index; MET, metabolic equivalent task; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research.

^aEnergy density was calculated as energy (kcal) from foods (solid foods, semi-solid foods, and liquid foods such as soups) divided by the weight (gram) of those foods (kcal per 100 g).

^bThe score for recommendations 3, 4, and 5 was the result of averaging the scores of each subrecommendation.

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Table 4. HRQoL Scores by the Tertiles of WCRF/AICR Recommendation Adherence Score

	WCRF/AICR Adherence Score									
	T1 (≤3; n=374)		T2 (3.5–4; n=438)		T3 (>4; n=488)		P_{trend}	Continuous ^a		
	LS Means	SE	LS Means	SE	LS Means	SE		LS Means	SE	P Value
EORTC QLQ-C30										
Global health status/QoL	64.25	0.92	65.58	0.84	67.34	0.8	.011	1.47	0.46	.001
Functioning										
Physical	89.00	0.59	90.30	0.54	92.18	0.52	<.001	1.39	0.29	<.001
Role	93.58	0.75	93.79	0.69	95.78	0.66	.024	1.24	0.38	<.001
Emotional	84.11	0.97	85.70	0.89	85.53	0.85	.300	0.43	0.48	.371
Cognitive	81.16	0.99	79.53	0.90	80.02	0.86	.429	-0.05	0.49	.906
Social	93.58	0.81	93.73	0.74	92.92	0.70	.512	0.16	0.40	.698
Symptom/Problem										
Fatigue	21.44	1.02	19.45	0.94	18.11	0.89	.016	-1.62	0.51	.002
Nausea and vomiting	2.47	0.33	2.00	0.30	0.96	0.29	<.001	-0.48	0.17	.003
Pain	21.85	1.19	19.39	1.09	17.29	1.04	.004	-2.19	0.59	<.001
Dyspnea	10.03	0.88	8.55	0.81	7.45	0.77	.030	-1.20	0.44	.007
Insomnia	23.52	1.49	23.05	1.37	22.49	1.30	.604	-0.48	0.74	.520
Loss of appetite	6.25	0.70	3.94	0.64	3.62	0.61	.007	-1.12	0.35	.001
Constipation	10.25	1.04	8.96	0.95	8.63	0.91	.254	-0.75	0.52	.148
Diarrhea	5.14	0.64	4.06	0.59	3.14	0.56	.020	-1.07	0.32	<.001
Financial impact	10.60	1.21	10.89	1.11	13.32	1.05	.081	0.82	0.60	.176

Models were adjusted for age at 18-month follow-up (years, continuous), education level at baseline (high school or below, college or above), marital status at 18-month follow-up (married or cohabitation, unmarried or divorced or widowed), total number of comorbidities at 18-month follow-up (0, 1, 2, 3), smoking status at 18-month follow-up (yes/no), stage at diagnosis (0, I, II, III), current hormonal therapy use at 18-month follow-up (yes/no), energy intake at 18-month follow-up (kcal per day, continuous), and menopausal status (premenopause, postmenopause).

Abbreviations: EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30; HRQoL, health-related quality of life; LS, least-square; SE, standard error; T, tertile of adherence score; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research.

^aDifference in HRQoL scores per unit of WCRF/AICR recommendation adherence score.

tively; $P_{\text{trend}}=.024$). The physical functioning score increased 1.39 points and role functioning score increased 1.24 points with each 1-point increment in adherence scores. For symptom evaluation, patients who had higher adherence to recommendations had significantly lower scores of symptoms (representing low level of symptoms), including fatigue (21.44 vs 19.45 vs 18.11, respectively; $P_{\text{trend}}=.016$), nausea and vomiting (2.47 vs 2.00 vs 0.96, respectively; $P_{\text{trend}}<.001$), pain (21.85 vs 19.39 vs 17.29, respectively; $P_{\text{trend}}=.004$), dyspnea (10.03 vs 8.55 vs 7.45, respectively; $P_{\text{trend}}=.030$), loss of appetite (6.25 vs 3.94 vs 3.62, respectively; $P_{\text{trend}}=.007$), and diarrhea (5.14 vs 4.06 vs 3.14, respectively; $P_{\text{trend}}=.020$). With each 1-point increment in adherence scores, the score of the above symptoms decreased accordingly: fatigue (-1.62 points), nausea and vomiting (-0.48 points), pain (-2.19 points), dyspnea (-1.20 points), loss of appetite (-1.12 points), and diarrhea (-1.07 points).

Association of Individual Recommendation Component Score at Follow-Up With HRQoL

We also examined the associations between HRQoL and 3 recommendation components (BMI, physical activity, and diet). After adjusting for clinical and

demographic factors, physical activity level, and adherence to dietary recommendations, patients with cancer who were within the normal BMI range had higher scores for physical functioning (Table 5; $P=.001$) and lower scores for fatigue ($P=.024$), pain ($P<.001$), and dyspnea ($P=.045$).

To evaluate the relationship between physical activity level and HRQoL, we included clinical and demographic factors, BMI, and adherence to dietary recommendations in the adjustment. Patients who adhered to the physical activity recommendations had significantly higher scores for global health status and QoL ($P<.001$) and physical functioning ($P=.003$), and lower scores for fatigue ($P=.002$), pain ($P=.018$), and dyspnea ($P=.021$) compared with patients who were nonadherent.

For analysis regarding diet, patients were categorized into 3 groups by the tertiles of dietary recommendations adherence score at 18-month follow-up. Apart from clinical and demographic factors, BMI and physical activity scores were also adjusted in this analysis. Those who had higher scores for dietary recommendations showed lower scores for symptoms, including nausea and vomiting ($P_{\text{trend}}=.005$), loss of

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Table 5. HRQoL Scores According to Components of WCRF/AICR Recommendation Adherence Score

HRQoL Items	BMI Score			Physical Activity Score			Dietary Adherence Score			<i>P</i> _{trend} ^c
	0 (n=705)	1 (n=595)	<i>P</i> Value ^a	0 (n=861)	1 (n=439)	<i>P</i> Value ^b	T1 (≤2.5; n=373)	T2 (3; n=323)	T3 (≥3.5; n=604)	
EORTC QLQ-C30, LS means (SE)										
Global health status/QoL	65.47 (0.67)	66.32 (0.73)	.395	64.48 (0.60)	68.56 (0.85)	<.001	65.12 (0.94)	65.89 (0.97)	66.30 (0.72)	.340
Functioning										
Physical	89.69 (0.43)	91.75 (0.47)	.001	89.95 (0.39)	91.96 (0.55)	.003	90.18 (0.61)	90.33 (0.63)	91.07 (0.47)	.228
Role	94.13 (0.55)	94.88 (0.60)	.359	93.95 (0.50)	95.50 (0.70)	.077	93.00 (0.78)	95.37 (0.80)	94.91 (0.60)	.089
Emotional	85.67 (0.70)	84.60 (0.77)	.313	84.70 (0.64)	86.12 (0.91)	.210	85.10 (1.00)	84.10 (1.03)	85.80 (0.77)	.476
Cognitive	79.96 (0.72)	80.44 (0.78)	.661	79.76 (0.65)	81.01 (0.92)	.275	81.46 (1.02)	80.63 (1.05)	79.15 (0.78)	.069
Social	92.89 (0.59)	93.97 (0.64)	.224	93.38 (0.53)	93.39 (0.75)	.987	93.81 (0.83)	93.54 (0.86)	93.04 (0.64)	.461
Symptom/Problem										
Fatigue	20.68 (0.74)	18.15 (0.81)	.024	20.78 (0.67)	17.05 (0.95)	.002	19.77 (1.05)	19.03 (1.09)	19.63 (0.81)	.981
Nausea and vomiting	1.99 (0.24)	1.45 (0.26)	.135	1.75 (0.22)	1.73 (0.31)	.942	2.32 (0.34)	2.16 (0.35)	1.17 (0.26)	.005
Pain	21.37 (0.86)	16.86 (0.94)	<.001	20.42 (0.78)	17.13 (1.11)	.018	19.64 (1.22)	19.30 (1.26)	19.10 (0.94)	.737
Dyspnea	9.45 (0.64)	7.52 (0.70)	.045	9.36 (0.58)	7.01 (0.81)	.021	8.51 (0.91)	8.76 (0.94)	8.49 (0.70)	.964
Insomnia	22.74 (1.09)	23.26 (1.19)	.750	23.36 (0.98)	22.26 (1.39)	.514	24.13 (1.54)	22.23 (1.59)	22.66 (1.18)	.511
Loss of appetite	4.93 (0.51)	3.96 (0.56)	.210	4.73 (0.46)	4.02 (0.66)	.389	5.95 (0.72)	4.14 (0.75)	3.77 (0.56)	.026
Constipation	8.78 (0.75)	9.71 (0.82)	.408	9.43 (0.68)	8.76 (0.97)	.574	10.93 (1.07)	9.29 (1.10)	8.09 (0.82)	.040
Diarrhea	4.44 (0.46)	3.53 (0.51)	.191	4.29 (0.42)	3.52 (0.60)	.299	5.45 (0.66)	3.42 (0.68)	3.47 (0.51)	.031
Financial impact	11.87 (0.88)	11.54 (0.96)	.800	11.87 (0.80)	11.42 (1.13)	.752	10.04 (1.25)	11.32 (1.29)	12.97 (0.96)	.064

Covariants included age at 18-month follow-up (years, continuous), education level at baseline (high school or below, college or above), marital status (married or cohabitation, unmarried or divorced or widowed), total number of comorbidities at 18-month follow-up (0, 1, 2, 3), smoking status at 18-month follow-up (yes/no), stage at diagnosis (0, I, II, III), current hormonal therapy use at 18-month follow-up (yes/no), energy intake at 18-month follow-up (kcal per day, continuous), and menopausal status (premenopause, postmenopause).

Abbreviations: BMI, body mass index; EORTC QLQ-C30, European Organization for Research and Treatment of Cancer Quality of Life Questionnaire-Core 30; HRQoL, health-related quality of life; LS, least-square; SE, standard error; QoL, quality of life; T, tertile of adherence score; WCRF/AICR, World Cancer Research Fund/American Institute for Cancer Research.

^aAdjust for covariants, physical activity score, and dietary adherence score.

^bAdjust for covariants, BMI score, and dietary adherence score.

^cAdjust for covariants, BMI score, and physical activity score.

appetite ($P_{\text{trend}} = .026$), constipation ($P_{\text{trend}} = .040$), and diarrhea ($P_{\text{trend}} = .031$).

Discussion

This is the first study to measure adherence to the WCRF/AICR guidelines before and after cancer diagnosis among Chinese patients with breast cancer. Our results indicated that patients tended to make positive changes for a healthier lifestyle after cancer diagnosis. We also examined the association between adherence to WCRF/AICR guidelines after cancer diagnosis and HRQoL, and found that higher adherence to WCRF/AICR recommendations after cancer diagnosis was associated with higher scores of global health status/QoL, physical and role functioning, and a series of improved symptoms. Among the 3 components of the WCRF/AICR guideline (BMI, physical activity, and diet), we found that adherence to the physical activity recommendations was associated with better global health status and QoL, better physical functioning, and lower scores for fatigue, pain, and dyspnea. Adherence to the BMI recom-

mendation also resulted in better physical functioning and lower scores for fatigue, pain, and dyspnea. Adherence to dietary recommendations was associated with lower scores for nausea and vomiting, loss of appetite, constipation, and diarrhea. Further, the significant associations between adherence to WCRF/AICR guidelines and HRQoL were also seen in sensitivity analysis (data not shown).

Many studies have shown that patients with breast cancer attempt to modify their lifestyles after cancer diagnosis.^{32–37} Behavioral changes typically included increased intake of fruit and vegetables, decreased meat intake, reduced smoking and alcohol consumption, and increased physical activity.^{32–37} Findings of those studies indicated that patients are willing and able to initiate positive changes. Our results further demonstrated that Chinese patients with breast cancer made significant changes in dietary intake and physical activity early after diagnosis, and suggested that “early after diagnosis” was an important period for patients to adopt healthy lifestyle habits. However, it may be possible that the patients willing to participate in this cohort were those

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who cared more about lifestyle behaviors, and therefore were more likely to change their lifestyles than the general breast cancer population.

Our finding of the association between higher adherence to WCRF/AICR guidelines and better HRQoL was consistent with the results of 2 previous studies.^{12,20} The American Cancer Society's (ACS) Study of Cancer Survivors-II examined the association between adherence to ACS recommendations for lifestyle behavior (physical activity, fruit and vegetable consumption, and smoking) and HRQoL among 6 groups of cancer survivors. Results indicated that patients who adhered to a greater number of recommendations had better overall HRQoL.¹² The IWHS reported that elderly female cancer survivors (age ≥ 65 years) who adhered to an increasing number of WCRF/AICR recommendations had higher physical and mental summary scores.²⁰ However, these studies mainly included long-term cancer survivors, with approximately two-thirds of the participants diagnosed >5 years prior to the study. On the other hand, a Korean cross-sectional study that assessed 160 patients who were between 6 months and >5 years from initial breast cancer diagnosis found that higher adherence to ACS recommendations was associated with better social functioning, whereas higher adherence to WCRF/AICR recommendations was associated with more serious arm symptoms (pain in arm or shoulder, arm or hand swollen and difficult to raise or move arm sideways).³⁸ In contrast, the present study assessed patients relatively early, with a median follow-up time from cancer diagnosis of 18 months. At the time of writing, patients just finished intense anticancer therapy, such as surgery, radiotherapy, and/or chemotherapy, which is a critical period for adopting lifestyle changes. This is supported by similar cohort studies that also assessed updates in lifestyle factors at 18 months after cancer diagnosis, including the Shanghai Breast Cancer Survival Study³⁹ and the DietCompLyf study.⁴⁰

Our study is the first to investigate the association between BMI and HRQoL among Chinese patients with breast cancer. We found that patients who adhered to the BMI recommendation had better physical functioning. Such association was in line with the results of previous studies, which demonstrated that greater BMI (≥ 25 kg/m²) was associated with poorer physical QoL.^{13,41,42} A systematic review of randomized trials among patients after primary

treatment for breast cancer suggested that physical activity has positive effects on physical functions and QoL.⁴³ Physical activity has been suggested to improve physical function through improving cardiovascular function.⁴⁴ Another meta-analysis that included 25 exercise intervention trials concluded that exercise interventions significantly improved overall QoL in breast cancer survivors.⁴⁵ Additionally, a systematic review found that aerobic exercise during or after adjuvant cancer therapy could significantly reduce fatigue in patients with breast cancer.⁴⁶ Together, this evidence supported our finding that patients with breast cancer who had been physically active showed better scores for global health status/QoL, physical functioning, and fatigue. Furthermore, a few intervention studies have shown that dietary modifications in addition to exercise interventions could induce weight loss and improve QoL in patients with breast cancer.⁴⁷⁻⁵⁰

This study measured both prediagnosis and post-diagnosis lifestyle behaviors to examine changes across a specific period. Additionally, we comprehensively recorded the demographic and clinical characteristics of our participants and adjusted those potential confounders during the analysis. Despite the study's strength, some limitations must be considered. First, our finding may not be generalized to all Chinese patients with breast cancer. Because Hong Kong is a relatively more Westernized and urbanized city in China, its population may have different lifestyle behaviors compared with populations in different localities. Second, the median follow-up time from diagnosis was relatively short. It will be important to prospectively follow these participants and determine if adherence perseveres. Inoue-Choi et al²¹ reported that higher adherence to the WCRF/AICR guidelines was associated with lower all-cause mortality among elderly female cancer survivors (aged ≥ 65 years). Prospective follow-up of the current cohort may allow us to determine whether this association exists among Chinese breast cancer survivors.

Third, although patients with breast cancer at 18-month follow-up had completed surgery, radiotherapy, and/or chemotherapy, the possible long-term influence of these treatments and the ongoing influence of endocrine therapy on HRQoL have not been assessed. Fourth, we acknowledge the potential recall bias of the impact of a breast cancer diagnosis

on patients' report of recent lifestyle and behavior changes. A better design may be to include appropriate comparison groups for investigating the impact of breast cancer diagnosis on a change in behavior. In addition, because the study design about the association between adherence to WCRF/AICR recommendation and HRQoL was similar to the study by Inoue-Choi et al,²⁰ potential bias similar to the latter study should be considered.

Lastly, our scoring methods to estimate the overall adherence to WCRF/AICR recommendations were based on a set of cutoff values adopted for this study, and this could have introduced potential differences in results compared with other studies using different scoring systems. For instance, although the IWHS used daily dietary fiber intake to construct the adherence score,²⁰ the cross-sectional study from South Korea used the tertiles

of the whole population to construct the adherence score.³⁸

Conclusions

Results of our study showed that Chinese patients with breast cancer made positive lifestyle changes after their cancer diagnosis and increased their adherence to WCRF/AICR guidelines. Moreover, higher adherence to WCRF/AICR recommendations among Chinese patients was associated with better global health status/QoL and physical and role functioning, and less serious symptoms. Our results provide evidence of the beneficial outcomes for patients with breast cancer adhering to the WCRF/AICR prevention guideline. Prospective follow-up data could confirm whether adherence to WCRF/AICR recommendations remains a long-term practice and whether this has an impact on cancer mortality.

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