Adherence to the World Cancer Research Fund/American Institute for Cancer Research Recommendations for Cancer Prevention Is Associated With Better Health-Related Quality of Life Among Elderly Female Cancer Survivors

Maki Inoue-Choi, DeAnn Lazovich, Anna E. Prizment, and Kim Robien

ABSTRACT

Purpose

The 2007 World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) diet and physical activity guidelines encourage cancer survivors to follow its cancer prevention recommendations. We evaluated whether adherence to the WCRF/AICR recommendations was associated with health-related quality of life (HRQOL) among elderly female cancer survivors.

Patients and Methods

A total of 2,193 women with a confirmed cancer diagnosis (1986 through 2002) in the Iowa Women's Health Study were identified. We calculated a WCRF/AICR recommendation adherence score (range, 0 to 7), assigning one point each for seven recommendations. Physical and mental component summary scores (PCS, MCS) from the Medical Outcomes Study Short Form-36 Health Survey were compared by recommendation adherence scores.

Results

Mean adherence score was 4.0 ± 1.2 . Overall, higher adherence to the WCRF/AICR guidelines was significantly associated with better PCS and MCS after adjustment for age, education, marital status, number of comorbidities, smoking, cancer stage, and current cancer treatment ($P_{\text{trend}} < .001$ for both). PCS was 43.5 versus 37.0 and MCS was 54.2 versus 52.0 among women with adherence scores ≥ 5 compared with women scoring ≤ 3 . Adherence to the physical activity recommendation was associated with higher PCS and MCS after adjusting for demographic and medical confounders, body mass index, and dietary recommendation adherence. For the body weight recommendation, adherence was associated with higher PCS but lower MCS, whereas adherence to the dietary recommendations was associated with higher MCS only.

Conclusion

Following the lifestyle guidelines for cancer prevention may improve HRQOL among elderly female cancer survivors. Physical activity may be a key lifestyle factor to improve HRQOL.

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INTRODUCTION

The combination of increasing cancer survival rates and an aging population has translated into an expanding number of elderly cancer survivors. As of 2008, approximately 60% of the nearly 12 million cancer survivors were 65 years of age or older.¹ Both aging and status as a cancer survivor may increase the risk for chronic health conditions and worsen health-related quality of life (HRQOL).^{2,3}

Healthy lifestyles such as maintaining normal body weight, staying physically active, and eating a healthy diet have well-described associations with decreased risk for primary cancers.^{4,5} Among cancer survivors, these health behaviors have been associated with cancer recurrence, mortality, and other

health outcomes such as chronic diseases.⁶⁻¹⁰ These data suggest that healthy behaviors may also be important to improve HRQOL among cancer survivors. HRQOL is a broad, multidimensional concept that usually includes measures of physical and mental health and their correlates, including health conditions, functional status, social support, and socioeconomic status.¹¹ Although evidence has been accumulating only recently, several studies have found that lifestyle factors, such as normal body weight, physical activity, and healthy diet, are individually associated with better HRQOL.¹²⁻²¹

In 2007, the World Cancer Research Fund/American Institute for Cancer Research (WCRF/AICR) Expert Panel conducted systematic reviews of the relevant literature on food, nutrition, physical

All authors: University of Minnesota, Minneapolis, MN; and Kim Robien, George Washington University, Washington, DC.

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Corresponding author: Maki Inoue-Choi, PhD, MS, 1300 S. Second St, Suite 300, Minneapolis, MN 55454; e-mail: inoue0021@umn.edu.

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activity, and cancer prevention and established eight recommendations on diet and physical activity to reduce cancer risk.⁵ Because of the insufficient quantity and quality of studies specific to cancer survivors, the Expert Panel encouraged cancer survivors to follow the lifestyle recommendations for primary cancer prevention. However, few studies have evaluated the combined effect of multiple lifestyle factors on HRQOL among cancer survivors.^{17,18} Here, we evaluated the hypothesis that higher adherence to the 2007 WCRF/AICR guidelines would be associated with better HRQOL assessed using the Medical Outcomes Study (MOS) Short Form–36 Health Survey (SF-36) physical and mental component summary scores among elderly female cancer survivors in the Iowa Women's Health Study (IWHS). We also evaluated the individual associations between adherence to body weight, physical activity, and dietary-specific recommendations and HRQOL.

PATIENTS AND METHODS

Study Population

The IWHS is a prospective cohort study to examine risk factors for cancer and other chronic diseases among postmenopausal women in Iowa.²² In brief, 41,836 women (55 to 69 years of age) responded to the 1986 baseline questionnaire on demographics, anthropometry, medical history, lifestyles, and dietary intake. The cohort participants were predominantly white (> 99%). Vital status and incident cancers are identified annually via linkage with the State Health Registry of Iowa, a member of the National Cancer Institute's Surveillance, Epidemiology and End Results program, supplemented by the National Death Index. The IWHS was approved by the institutional review board of the University of Minnesota. The return of the questionnaires was considered as a subject's consent to participate in the study.

Follow-up questionnaires were administered by mail in 1987, 1989, 1992, 1997, and 2004. Of the 30,232 women believed to be alive, 20,844 women (68.9%) completed the final follow-up questionnaire in 2004. Responders were younger and had higher education compared with nonresponders.² Women who reported a previous cancer diagnosis in the baseline questionnaire ($n = 1,511$), who did not complete the 2004 HRQOL questions ($n = 1,863$), whose questionnaire was completed by proxy ($n = 3$), and who reported a cancer diagnosis that was not identified by the cancer registry ($n = 82$) were excluded from analysis. Among the remaining women, incident cancers diagnosed between 1986 and 2002 were identified. Women diagnosed less than 2 years before the 2004 follow-up were excluded on the grounds that they were more likely to be undergoing cancer treatment and have different behavioral patterns, as well as HRQOL, compared with longer-term survivors. Women who did not report weight, height, or physical activity level ($n = 75$) and who reported implausible dietary intake (> 30 items blank or energy intake estimates < 600 or > 5,000 kcal/d on the food frequency questionnaire; $n = 175$) were excluded, resulting in 2,193 cancer survivors for analysis.

Data Collection

The 2004 questionnaire reassessed demographics, medical history, lifestyles, and dietary intake and included the MOS SF-36 version 2, a validated self-report survey for global assessment of HRQOL across various physical and psychosocial domains.²³ Body mass index (BMI) was computed using self-reported height and weight. Survivors were categorized into three physical activity levels: high if they reported ≥ 2 times/wk vigorous or ≥ 5 times/wk moderate activities, moderate if they reported 2 to 4 times/wk moderate or once/wk vigorous and moderate activities, or otherwise low.²⁴ Usual intake of 127 food items during the past 12 months was assessed using the Harvard food frequency questionnaire,^{25,26} which has been validated in the IWHS population.²⁷ Usual intake of food groups (eg, total vegetables and red meat) was computed based on a serving size for each food item.

The total comorbidity count included self-reported presence of comorbid conditions assessed in the baseline and any follow-up questionnaires that could affect HRQOL.^{28–30} These comorbid conditions include Parkinson dis-

ease, rheumatoid arthritis, diabetes, hip fractures, hypertension, heart attack, heart disease, and stroke. Diagnosis date, sites, and stages of cancers; first course of treatment; and subsequent cancer were obtained via the cancer registry linkage. A single question was asked in the 2004 questionnaire about whether a woman was currently undergoing cancer treatment.

Adherence Scores

Adherence to the 2007 WCRF/AICR cancer prevention guidelines⁵ was determined using the scoring pattern outlined in Table 1. Participants received one point for each indicator if they met recommendation, or zero if they did not. The recommendation to limit energy-dense foods was excluded as an indicator because calorie intake by food grams was not available. The recommendation against dietary supplement use for cancer prevention was also excluded, because we were unable to ascertain a reason for supplement use (eg, nutrition repletion *v* general health improvement). Scores for the seven indicators were summed as the recommendation adherence score (range, zero to seven). We further separated the adherence score into three components of the WCRF/AICR guidelines: body weight (zero to one), physical activity (zero to one), and diet (zero to five).

Quality-of-Life Measurement

The MOS SF-36 includes 36 questions and yields an eight-scale profile of HRQOL. Each scale was standardized to age-specific 1998 US population norms using established algorithms.^{31,32} A mean of 50 represents the population average, with one point below or above the mean indicating one tenth of a standard deviation (SD).³³ On the basis of the eight scale scores, we calculated a physical component summary score (PCS) and a mental component summary score (MCS), aggregate summary measures constructed on the basis of factor analyses of correlations among the eight scales.³² Although components of each scale are incorporated into both PCS and MCS, physical functioning, role-physical, bodily pain, and general health scales were the primary contributors to PCS; vitality, social functioning, role-emotional, and mental health scales were the primary contributors to MCS.

Analysis and Statistical Methods

Cancer survivors were categorized into three groups according to their recommendation adherence scores: low (≤ 3), average ($= 4$; mean), and high adherence (≥ 5). General linear regression was used to compare least-square means and SEs of PCS and MCS by levels of recommendation adherence (low, average, and high) and continuous recommendation adherence scores. Potential demographic and medical confounders included in the final models (age, education level at study baseline, marital status, total number of comorbidities through 2004, smoking status, cancer stage, and current cancer treatment) were determined a priori based on previous literature.^{16–18,34–36} We further stratified the analysis by common cancer types and time since diagnosis.

PCS and MCS were also examined in relation to each of the three components of the adherence score (body weight, physical activity, and diet). To evaluate the effect of any one component of adherence scores on HRQOL beyond the effects of the other components, the analysis of each component was adjusted for the other components. Statistical significance was defined as $P < .05$. A clinically significant difference in PCS and MCS was defined as five points (1/2 SD US population norms).³⁷

RESULTS

In Table 2, demographic and lifestyle characteristics are described for cancer survivors overall and by levels of recommendation adherence. The average age of the cancer survivors at the time of the 2004 follow-up was 78.9 years (SD = 3.9 years; range, 72 to 88 years). The average duration of survival was 8.9 years (SD = 4.7 years); 27%, 32%, and 41% of women had survived cancer for 2 to less than 5 years, 5 to 10 years, and more than 10 years, respectively. The three most common cancer types were breast, colorectal, and gynecologic. Almost 75% of the survivors had local cancer or cancer in situ. Nearly 95% received surgery as a first course of cancer therapy. Thirteen percent

Table 1. The 2007 WCRF/AICR Recommendations for Cancer Prevention and Adherence Score Assignment Among 2,193 Cancer Survivors in the Iowa Women's Health Study

WCRF/AICR Recommendation	IWHS 2004 Data	Value	Score	No.	%
1. Be as lean as possible without becoming underweight	BMI	$\leq 25 \text{ kg/m}^2$	1	853	38.9
		$> 25 \text{ kg/m}^2$	0	1,340	61.1
2. Be physically active, for at least 30 min every day	Physical activity level	Moderate/high	1	1,056	48.2
		Low	0	1,137	51.9
3. Limit consumption of energy-dense foods. Avoid sugary drinks	Not included*	—			
4. Eat more of a variety of vegetables, fruits, whole grains, and legumes such as beans	Total fruit and vegetable intake frequency	$\geq 5 \text{ servings/d}$	1	1,346	61.4
		$< 5 \text{ servings/d}$	0	847	38.6
	Daily dietary fiber intake	$\geq 25 \text{ g/d}$	1	692	31.6
		$< 25 \text{ g/d}$	0	1,501	38.5
5. Limit consumption of red meats (such as beef, pork and lamb) and avoid processed meats	Daily red meat intake	$< 80 \text{ g/d}$	1	1,173	53.5
		$\geq 80 \text{ g/d}$	0	1,020	46.5
6. Limit alcoholic drinks to 2 for men and 1 for women a day, if consumed at all	Daily alcohol intake	$< 14 \text{ g/d}$	1	2,092	95.4
		$\geq 14 \text{ g/d}$	0	101	4.6
7. Limit consumption of salty foods and foods processed with salt	Daily sodium intake	$< 2,400 \text{ mg/d}$	1	1,632	74.4
		$\geq 2,400 \text{ mg/d}$	0	561	25.6
8. Don't use supplements to protect against cancer	Not included†	—			
9. It is best for mothers to breastfeed exclusively for up to 6 months	Not included‡	—			
10. Cancer survivors should follow the recommendations for cancer prevention (after treatment)					

Abbreviations: AICR, American Institute for Cancer Research; IWHS, Iowa Women's Health Study; WCRF, World Cancer Research Fund.
 *Dietary intake data by food grams were not available.
 †Reported dietary supplement use in our study may have been for nutrient repletion and therefore not included in the analysis.
 ‡Special population recommendations and thus not included in the analysis.

had experienced a subsequent cancer, and 9.8% reported undergoing cancer treatment at the time of the final follow-up in 2004. Mean recommendation adherence score among all survivors was 4.0 (SD = 1.2). Women who showed higher adherence to the recommendations had higher education level, fewer comorbid conditions, and lower prevalence of current smoking. Excellent or good perceived general health was reported by 84% and 73% of women in the high (adherence to five or more of seven recommendations) and low (adherence to three or fewer of seven recommendations) adherence levels, respectively. Age at diagnosis, cancer type, cancer stage, first course of cancer therapy, subsequent cancer, and current cancer treatment were not different across recommendation adherence levels.

Mean PCS and MCS were 40.2 and 53.0, respectively, comparable to US population norms among women ≥ 75 years of age.³³ Higher recommendation adherence was associated with higher PCS and MCS (Table 3; $P_{\text{trend}} < .001$ for both). PCS increased 2.3 and MCS increased 0.9 points with each one-point increment in adherence scores. For PCS, a clinically meaningful difference was observed between women in the high (43.5) versus low (37.0) adherence levels. This association between recommendation adherence and PCS was consistent across common cancer types and time since diagnosis. For MCS, a smaller difference (2.2 points, $P < .001$) favoring survivors in the high adherence level was observed. This association between recommendation adherence and MCS was also observed among breast and colorectal cancer survivors and among short-term (2 to 5 years) and long-term (> 10 years) survivors, but the difference in MCS across adherence levels among gynecologic cancer survivors and women surviving 5 to 10 years did not reach statistical significance.

Cancer survivors with a BMI $\leq 25 \text{ kg/m}^2$ experienced higher PCS but lower MCS compared with those with a BMI more than 25 kg/m^2 (Table 4; $P < .001$ for both); adjustment for demographic and medical confounders, physical activity level, and adherence to dietary recommendations did not meaningfully change the difference in these scores. PCS and MCS were also higher among survivors who met the physical activity recommendation compared with those who did not ($P < .001$ for both), regardless of adjustment for BMI and adherence to dietary recommendations. For dietary recommendations, survivors who met more recommendations had higher PCS and MCS ($P_{\text{trend}} < .001$ for both). However, differences across adherence levels were attenuated with adjustment for BMI and physical activity level, remaining statistically significant only for MCS ($P_{\text{trend}} = .03$). Among the five dietary recommendations, PCS was higher only with adherence to fruit and vegetable ($P = .02$) and dietary fiber ($P = .03$) intake recommendations, even with adjustment for BMI and physical activity level. MCS was higher only with adherence to the recommendations for reduced red meat ($P = .006$) and sodium ($P = .0003$) intake. Adherence to the recommendation for less alcohol intake was not associated with PCS or MCS after adjustment for BMI and physical activity level.

DISCUSSION

We found that elderly female cancer survivors who met a greater number of the WCRF/AICR recommendations had better physical and mental HRQOL. In some instances, the differences in PCS and

Table 2. Characteristics of 2,193 Cancer Survivors by the 2007 WCRF/AICR Recommendation Adherence Scores

Characteristic	All	Adherence Score			P*
		≤ 3	4	≥ 5	
No. of survivors	2,193	736	709	748	
Recommendation adherence score					<.001
Mean	4.0	2.7	4.0	5.4	
SD	1.2	0.5	0	0.6	
Age, years					.06
Mean	78.9	78.6	79.0	79.0	
SD	3.9	3.8	4.0	3.9	
Education level, %†					
< High school	13.9	16.3	13.3	12.2	.006
High school	41.8	44.1	42.3	39.0	
Some college	44.3	39.6	44.4	48.8	
Marital status, %					.02
Married	45.5	46.7	41.9	47.9	
Widowed	47.3	47.7	49.0	45.2	
Divorced	4.8	4.5	5.9	4.1	
Never married	2.4	1.1	3.2	2.8	
No. of comorbid conditions, %‡					
None	14.5	12.2	14.7	16.6	<.001
1	25.8	22.7	23.5	30.9	
2	27.0	28.0	27.2	25.9	
≥ 3	32.7	37.1	34.6	26.6	
Current smoking, %	3.2	4.6	3.0	2.0	.01
Perceived general health, %					
Excellent or good	76.9	72.8	73.6	84.1	<.001
Fair or poor	23.1	27.2	26.4	15.9	
Age at cancer diagnosis, years					.10
Mean	70.1	69.7	70.3	70.2	
SD	6.1	5.6	6.1	6.3	
Cancer type, %					.12
Breast	47.2	48.8	46.4	46.4	
Colorectal	17.4	16.2	16.3	19.6	
Gynecologic	12.9	14.7	13.0	11.1	
Other	22.5	20.4	24.3	22.9	
Cancer stage, %					.53
In situ	12.4	12.9	11.2	13.1	
Local	62.3	64.1	61.4	61.3	
Regional	18.3	16.6	19.3	19.0	
Distant	5.0	4.4	5.6	5.1	
Unknown	2.0	2.0	2.5	1.5	
First course of cancer treatment, %					
Surgery	94.2	94.3	93.9	94.5	.88
Chemotherapy	15.0	14.7	14.8	15.3	.94
Radiation	21.3	21.9	20.7	21.2	.86
Immunotherapy	2.2	2.5	1.8	2.1	.73
Hormone therapy	20.7	21.5	20.3	20.3	.81
Time since diagnosis, years, %					
2- < 5	26.8	25.5	27.5	27.3	.63
5-10	32.0	34.0	30.2	31.7	
> 10	41.2	40.5	42.3	41.0	
Subsequent cancer, %	13.0	12.5	13.1	13.4	.88
Current cancer treatment, %	9.8	11.5	10.1	8.0	.07

Abbreviations: AICR, American Institute for Cancer Research; SD, standard deviation; WCRF, World Cancer Research Fund.

*P values from χ^2 test for categorical variables and P values for trend from t test for continuous variables.

†Data collected at baseline (1986); other data were collected at the 2004 follow-up.

‡Accumulated comorbid conditions up to 2004, including diabetes, hypertension, heart disease, heart attack, stroke, hip fracture, rheumatoid arthritis, and Parkinson disease.

MCS between survivors who showed high and low levels of adherence to the recommendations were clinically meaningful. This finding is consistent with a previous report that meeting the American Cancer Society's recommendations for physical activity and diet⁴ was associated with better HRQOL among cancer survivors.¹⁸ Of the three components in the adherence score—body weight, physical activity, and diet—we found that adherence to the physical activity recommendation resulted in the largest differences in PCS and MCS. However, results were mixed for the relationship between adherence to body weight and dietary recommendations and PCS and MCS.

A recent systematic review of intervention trials among cancer survivors concluded that exercise may improve overall HRQOL and certain HRQOL domains (eg, body image/self-esteem, emotional well-being, and social functioning); however, no conclusions were drawn regarding other HRQOL domains (eg, physical functioning and cognitive function).³⁸ Higher physical activity level was shown to improve physical HRQOL through improvement of cardiopulmonary function, muscular strength, and other mechanisms.^{20,39} Impacts of physical activity on mental HRQOL among older adults have been inconclusive,^{20,40,41} but physical activity may influence mental well-being by reducing depression, anxiety, and stress; improving mood states and sleep; and enhancing self-esteem.^{42,43}

Many studies have demonstrated that obesity is associated with poor HRQOL, especially physical HRQOL among elderly adults.^{17,21,44,45} Obese people are more likely to experience social discrimination and have lower self-esteem than normal-weight individuals and thus have poor mental HRQOL.⁴⁶ In fact, obesity has been associated with higher risk for depression and other psychiatric disorders and suicidal behavior.⁴⁷⁻⁴⁹ However, having a lower BMI could be a result of advanced cancer or other health conditions among elderly cancer survivors.⁴⁵ A U-shaped association between BMI and all-cause mortality, with overweight individuals at the lowest risk, has been identified among the elderly.⁵⁰⁻⁵² Therefore, the association between normal body weight and lower mental HRQOL observed in our study might be partly explained by residual confounding by cancer characteristics and comorbid conditions.

To date, most studies evaluating diet and HRQOL among cancer survivors have focused on a single dietary recommendation (eg, fruit and vegetable intake)^{18,19} and/or one cancer type (eg, breast cancer).^{15,16} A recent cross-sectional analysis of older long-term cancer survivors (breast, prostate, and colorectal cancer) showed that better dietary quality was correlated with higher physical HRQOL, but not with mental HRQOL.¹⁷ However, other studies of breast cancer survivors suggested that better dietary quality may influence mental HRQOL.^{15,16} Weight control is a suggested mechanism by which healthy diets influence health outcomes and indeed is a main aim of the WCRF/AICR lifestyle guidelines.⁵ However, given the low correlation between body weight and dietary recommendation adherence scores (Spearman correlation coefficient, $r = 0.04$) in our study, other mechanisms may also exist.

Interventions may be more effective in improving HRQOL among cancer survivors if they address multiple health behaviors. The first randomized controlled trial of a multiple health behavior intervention (exercise, diet quality, and modest weight loss; 12 months) among older long-term survivors of three major cancers (breast, prostate, and colorectal) was conducted recently.¹⁷ Survivors in the intervention group experienced clinically meaningful improvements both

Table 3. Physical and Mental Component Summary Scores by the 2007 WCRF/AICR Recommendation Adherence Score

	No. of survivors	Adherence Score									
		≤ 3		4		≥ 5		<i>P</i> _{trend}	Continuous*		
		Least-Square Mean	SE	Least-Square Mean	SE	Least-Square Mean	SE		Least-Square Mean	SE	<i>P</i>
Physical Component Summary Score											
All survivors	2,193										
Age and comorbidity adjusted		37.0	0.4	39.9	0.4	43.6	0.4	<.001	2.3	0.2	<.001
Full model†		37.0	0.4	40.0	0.4	43.5	0.4	<.001	2.3	0.2	<.001
Cancer type											
Breast cancer	1,035										
Age and comorbidity adjusted		37.2	0.5	40.0	0.5	43.7	0.5	<.001	2.3	0.2	<.001
Full model†		37.4	0.5	40.0	0.5	43.6	0.5	<.001	2.3	0.2	<.001
Colorectal cancer	382										
Age and comorbidity adjusted		39.0	0.9	41.9	0.9	44.9	0.8	<.001	2.3	0.4	<.001
Full model†		39.0	0.9	41.9	0.9	44.8	0.8	<.001	2.3	0.4	<.001
Gynecologic cancer	283										
Age and comorbidity adjusted		36.7	0.9	41.1	1.0	42.9	1.0	<.001	2.3	0.5	<.001
Full model†		36.6	0.9	41.2	1.0	42.8	1.0	<.001	2.3	0.5	<.001
Time since diagnosis, years											
2-< 5	587										
Age and comorbidity adjusted		36.5	0.7	40.1	0.7	43.0	0.7	<.001	2.3	0.4	<.001
Full model†		36.8	0.8	39.9	0.7	43.0	0.7	<.001	2.4	0.4	<.001
5-10	701										
Age and comorbidity adjusted		37.4	0.6	39.6	0.6	43.9	0.6	<.001	2.2	0.3	<.001
Full model†		37.3	0.6	39.8	0.7	43.8	0.6	<.001	2.2	0.3	<.001
> 10	905										
Age and comorbidity adjusted		37.0	0.6	39.9	0.6	43.8	0.5	<.001	2.4	0.3	<.001
Full model†		37.0	0.6	40.0	0.6	43.7	0.5	<.001	2.4	0.3	<.001
Mental Component Summary Score											
All survivors	2,193										
Age and comorbidity adjusted		51.9	0.3	52.7	0.3	54.3	0.3	<.001	0.9	0.2	<.001
Full model†		52.0	0.3	52.8	0.3	54.2	0.3	<.001	0.8	0.2	<.001
Cancer type											
Breast cancer	1,035										
Age and comorbidity adjusted		51.9	0.5	53.5	0.5	54.7	0.5	<.001	0.9	0.2	<.001
Full model†		52.0	0.5	53.6	0.5	54.6	0.5	<.001	0.8	0.2	<.001
Colorectal cancer	382										
Age and comorbidity adjusted		51.2	0.8	53.8	0.8	54.2	0.7	.009	1.1	0.4	.006
Full model†		51.4	0.8	53.8	0.8	54.1	0.8	.02	0.9	0.4	.02
Gynecologic cancer	283										
Age and comorbidity adjusted		52.7	0.9	53.1	0.9	53.8	1.0	.41	0.7	0.5	.14
Full model†		52.9	0.9	52.9	0.9	53.5	1.0	.66	0.4	0.5	.35
Time since diagnosis, years											
2-< 5	587										
Age and comorbidity adjusted		52.0	0.7	52.3	0.7	54.8	0.7	.003	0.9	0.3	.006
Full model†		51.9	0.7	52.3	0.7	54.8	0.6	.003	0.9	0.3	.01
5-10	701										
Age and comorbidity adjusted		52.8	0.6	53.9	0.6	54.3	0.6	.08	0.6	0.3	.04
Full model†		52.9	0.6	54.0	0.6	54.1	0.6	.19	0.5	0.3	.10
> 10	905										
Age and comorbidity adjusted		51.1	0.5	52.2	0.5	54.0	0.5	<.001	1.1	0.3	<.001
Full model†		51.1	0.5	53.3	0.5	53.9	0.5	<.001	1.0	0.3	<.001

Abbreviations: AICR, American Institute for Cancer Research; WCRF, World Cancer Research Fund.

*Difference in Physical Component Summary Score or Mental Component Summary Score per unit of adherence scores.

†Adjusted for age at the 2004 follow-up, total comorbidities up to the 2004 follow-up, education level at cohort baseline (1986), marital status at the 2004 follow-up, current smoking at the 2004 follow-up, cancer stage, and current cancer treatment.

in physical function and other HRQOL.⁵³ The term “teachable moment” has been used in behavioral science to describe naturally occurring life or health events that motivate individuals to adopt healthier lifestyles.⁵⁴ A cancer diagnosis may be a teachable moment that

prompts individuals to make lifestyle changes and offers an opportunity to recommend changes in multiple areas.^{55,56}

The present study has several strengths. At the 2004 survey, the cohort had been followed for 18 years, and almost 2,200 cancer

Table 4. Physical and Mental Component Summary Scores by the Body Weight, Physical Activity, and Dietary Recommendation Adherence Scores

WCRF/AICR Recommendation Components*	Adherence Score				P		
	0		1				
	Least-Square Mean	SE	Least-Square Mean	SE			
Body weight							
No. of survivors	1,340		853				
PCS							
Model 1	38.8	0.3	42.4	0.3	< .001		
Model 1 + PA and diet	39.1	0.3	41.9	0.3	< .001		
MCS							
Model 1	53.6	0.3	52.1	0.3	.004		
Model 1 + PA and diet	53.7	0.3	51.8	0.3	< .001		
Physical activity							
No. of survivors	1,137		1,056				
PCS							
Model 1	36.6	0.3	44.0	0.3	< .001		
Model 1 + BMI and diet	37.0	0.3	43.6	0.3	< .001		
MCS							
Model 1	51.5	0.3	54.6	0.3	< .001		
Model 1 + BMI and diet	51.5	0.3	54.7	0.3	< .001		
Diet†	Adherence Score						P _{trend}
	< 3		3		> 3		
	Least-Square Mean	SE	Least-Square Mean	SE	Least-Square Mean	SE	
No. of survivors	421		1,074		698		
PCS							
Model 1	37.0	0.4	40.0	0.3	43.5	0.4	< .001
Model 1 + BMI and PA	40.1	0.4	39.9	0.4	40.6	0.4	.38
MCS							
Model 1	52.0	0.3	52.8	0.3	54.2	0.3	< .001
Model 1 + BMI and PA	52.4	0.4	52.7	0.3	53.8	0.4	.03
Individual Dietary Recommendations	Adherence Score						P
	0		1				
	Least-Square Mean	SE	Least-Square Mean	SE			
Fruits and vegetables							
PCS							
Model 1	39.1	0.3	40.9	0.3			< .001
Model 1 + BMI and PA	39.6	0.3	40.6	0.3			.02
MCS							
Model 1	52.5	0.3	53.3	0.3			.04
Model 1 + BMI and PA	52.7	0.3	53.2	0.3			.25
Dietary fiber							
PCS							
Model 1	39.7	0.3	41.3	0.4			.003
Model 1 + BMI and PA	39.9	0.2	40.8	0.3			.03
MCS							
Model 1	53.1	0.2	52.8	0.4			.47
Model 1 + BMI and PA	53.2	0.2	52.5	0.4			.11
Red meat							
PCS							
Model 1	40.1	0.3	40.3	0.3			.72
Model 1 + BMI and PA	40.3	0.3	40.1	0.3			.77
MCS							
Model 1	52.3	0.3	53.6	0.3			.001
Model 1 + BMI and PA	52.3	0.3	53.6	0.3			.006
(continued on following page)							

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Table 4. Physical and Mental Component Summary Scores by the Body Weight, Physical Activity, and Dietary Recommendation Adherence Scores (continued)

Individual Dietary Recommendations	Adherence Score				<i>P</i>
	0		1		
	Least-Square Mean	SE	Least-Square Mean	SE	
Alcohol					
PCS					
Model 1	42.7	1.0	40.1	0.2	.01
Model 1 + BMI and PA	41.4	0.9	40.1	0.2	.16
MCS					
Model 1	53.9	0.9	53.0	0.2	.33
Model 1 + BMI and PA	53.8	0.9	53.0	0.2	.34
Sodium					
PCS					
Model 1	40.6	0.4	40.0	0.2	.24
Model 1 + BMI and PA	40.8	0.4	40.0	0.2	.09
MCS					
Model 1	51.8	0.4	53.4	0.2	<.001
Model 1 + BMI and PA	51.8	0.4	53.4	0.2	<.001

Abbreviations: AICR, American Institute for Cancer Research; BMI, body mass index (continuous); MCS, Mental Component Summary Score; PA, physical activity level physical activity level (low, moderate, and high); PCS, Physical Component Summary Score; WCRF, World Cancer Research Fund.

*Model 1 included age at diagnosis, education level at baseline, marital status at the 2004 follow-up, total comorbidities up to the 2004 follow-up, and smoking at the 2004 follow-up as covariates.

†Total adherence score for five dietary recommendations (fruits and vegetables, dietary fiber, red meat, alcohol, and sodium intakes) ranged from 0 to 5.

survivors were identified for analysis. The 2004 questionnaire reassessed lifestyle factors; therefore, we could assess overall adherence to the WCRF/AICR recommendations for three lifestyle factors. Comorbidities and other factors that may confound the association between recommendation adherence and HRQOL were also available for adjustment in the analysis. Furthermore, healthier behaviors often coexist.¹⁸ Although body weight, physical activity, and dietary recommendation adherence scores were weakly correlated ($r = 0.04$ to 0.12), adjustment for the other health behaviors enabled us to separate the effects of these three lifestyle factors on HRQOL. Another strength is the extremely low prevalence of smoking (3%), which is a well-known risk factor for cancer and has been associated with HRQOL among cancer survivors.¹⁸ We adjusted all analyses for smoking status, and residual confounding is likely minimal due to the low smoking prevalence.

We assessed HRQOL using summary scores rather than the eight SF-36 scales for several reasons. First, the two summary measures reduce the number of statistical tests, thereby reducing the possibility of drawing statistically significant results by chance. Second, substantial correlations among the SF-36 scales are taken into account and adjusted for in computation of PCS and MCS. Third, PCS and MCS have had considerably greater precision for general physical and mental health outcomes than specific scales.⁵⁷ However, PCS and MCS are derived from a combination of the eight scales, and therefore they do not show which scale contributes to higher or lower PCS and MCS. Each scale may be more informative than the summary scores in terms of specific aspects of HRQOL. However, our aim here is to evaluate whether overall adherence to lifestyle guidelines is associated with overall HRQOL to contribute to the development of evidence-based lifestyle guidelines for cancer survivors. We did not report associations of recommendation adherence with the eight SF-36 scales, because we found it unwieldy to interpret the large number of associations between multiple exposures and outcomes, especially the associations

without clear mechanisms (eg, dietary recommendation adherence and body pain).

Cancer survivors' lifestyles and HRQOL were assessed at a single time point. We were thus unable to identify whether adherence was a long-term practice or not. In addition, health behaviors may have influenced HRQOL, but it is also possible that HRQOL affected health behaviors. For example, higher physical activity may have improved HRQOL, whereas women with higher HRQOL might have been more capable of being physically active. Our findings among elderly and mostly white (99.6%) women may not be applicable to men, young and middle-aged adults, and ethnic minority populations. Survival bias may also exist because our study participants were women who survived their cancer and were healthy enough to complete the 2004 follow-up questionnaire. Lastly, although we adjusted the analysis for cancer stage, current cancer treatment, and total comorbidity counts, possible residual confounding by measured and/or unmeasured cancer characteristics and comorbidities cannot be ruled out.

In summary, our results show that meeting the 2007 WCRF/AICR guidelines for cancer prevention is associated with better HRQOL, especially physical HRQOL, among elderly female cancer survivors. Encouraging overall adherence to lifestyle guidelines for cancer prevention may be an effective way to improve HRQOL among elderly female cancer survivors.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

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

AUTHOR CONTRIBUTIONS

Conception and design: Maki Inoue-Choi, Kim Robien

Administrative support: Kim Robien

Data analysis and interpretation: All authors
Manuscript writing: All authors

Final approval of manuscript: All authors

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