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Dietary Patterns Differ between Urban and Rural Older, Long-Term Survivors of Breast, Prostate, and Colorectal Cancer and Are Associated with Body Mass Index

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Abstract

Background—Older adult cancer survivors are at great er risk of cancer recurrence and other comorbidities that may be prevented through improved diet and weight management. The tertiary

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prevention needs of rural-dwelling survivors may be even greater, yet little is known about rural and urban differences in lifestyle factors among this high risk population.

Objectives—To compare dietary patterns of urban and rural cancer survivors and to examine associations of dietary patterns with BMI.

Design—A secondary analysis was performed of baseline data from the Reach Out to Enhance Wellness (RENEW) trial, a diet and exercise intervention among overweight, long-term (> 5y) older survivors of colorectal, breast, and prostate cancer. Survivors in the present analysis (n = 729) underwent two 45–60 minute telephone surveys, which included two 24-hour dietary recalls. Principal Components Analysis (PCA) and multivariable general linear models were used to derive dietary patterns and to evaluate associations between dietary patterns and BMI, respectively.

Results—PCA identified three primary dietary patter ns among rural dwellers ("high sweets and starches", "high reduced-fat dairy, cereal, nuts, and fruits", and "mixed") and three among urban dwellers ("high fruits and vegetables", "high meat and refined grains", and "high sugar-sweetened beverages"). Among rural survivors, greater adherence to the "high reduced-fat dairy, cereal, nuts, and fruits" pattern was positively associated with lower BMI (p-trend < 0.05) whereas higher scores on the "mixed" pattern was associated with greater BMI (p-trend < 0.05). Greater adherence to the "high fruits and vegetables" pattern among urban survivors was inversely associated with BMI (p-trend < 0.05).

Conclusions—Urban and rural differences in dietary intake behavior should be considered in designing public health interventions among the increasing population of older cancer survivors. Furthermore, targeting overall dietary patterns may be one approach to help reduce the burden of obesity among this population.

Keywords

dietary patterns; cancer survivors; body mass index; geographic residence

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INTRODUCTION

Nearly 13 million Americans have a history of cancer (1) and more than seven million of these cancer survivors are aged 65 years or older (2). Cancer survivors are at increased risk not only for cancer recurrence, but also for new primary tumors, secondary tumors, cardiovascular disease, diabetes, and other chronic diseases (3, 4). Contrary to the perception of cancer-associated cachexia, individuals diagnosed with early stage breast, prostate, and colorectal cancers are often overweight or obese (5). Excess weight and poor lifestyle behaviors are associated with this increased risk of cancer recurrence and chronic disease (3).

One lifestyle behavior that affects risk for obesity and other chronic diseases is dietary intake behavior. An analysis of data from the population-based National Health Interview Study (NHIS) found poor adherence rates to national dietary recommendations among cancer survivors (6). Only one-half of older survivors (> 65y) consumed at least 5 servings of fruits and vegetables per day; 45% adhered to a low-fat diet (< 30% of calories from fat); and a mere 8% consumed greater than 25 grams of dietary fiber per day. Despite the increased chronic disease risk, survivors are no more likely than those without a history of cancer to engage in recommended preventive lifestyle behaviors (7).

The aging population coupled with increasing screening and cure rates forecasts that the number of older adult cancer survivors in the US will continue to expand. Although a majority of this growing population is not adhering to current health recommendations (6), most report high levels of interest in health promotion programs, with 85% expressing interest in programs that promote a healthful diet and 83% in exercise initiatives (8). Thus, older adult cancer survivors are an important target population, with great promise for successful outcomes, in health promotion and disease prevention efforts. A focus on improving overall dietary patterns, as opposed to single nutrients, foods, or other individual dietary constituents, may be an effective nutritional strategy for meeting long-term dietary compliance (9) and disease prevention goals (10). Dietary patterns are defined are defined as the quality, quantity, and proportions of foods and beverages consumed in the diet as well as the frequency of consumption (11).

Studies investigating the potential role of geographic residence on dietary intake behavior are lacking, yet dietary patterns likely differ between urban and rural survivors due to differences in educational attainment, financial resources, and access to healthier food options (12), among other reasons. Although dietary patterns have not been examined for differences by geographic location in the US, obesity prevalence has been found to differ between rural and urban residents, with higher prevalence rates observed in rural compared to urban areas (13). Given the association of dietary patterns and obesity (14, 15), differences in dietary intake behavior may partially account for these variations in obesity prevalence.

An improved understanding of differences in dietary patterns between rural and urban residents is warranted to design and develop effective public health interventions to improve lifestyle behaviors and reduce the burden of obesity among the increasing population of cancer survivors. In addition, no studies to date have investigated associations between dietary patterns and BMI among older, long-term cancer survivors. Therefore, the purpose of this study was to describe and compare dietary patterns of urban and rural older, long-term (> 5y), overweight survivors of breast, prostate, and colorectal cancer and to determine whether these dietary patterns were associated with degree of overweight.

METHODS

Study Design and Participants

Participants were overweight, long-term (> 5y) older survivors of colorectal, breast, and prostate cancer who underwent screening and baseline interviews for Reach out to ENhance Wellness (RENEW) trial between July 1, 2005 to May 17, 2007. The RENEW study was a National Cancer Institute (NCI)-supported randomized controlled trial designed to test the efficacy of a home-based diet and physical activity intervention aimed at positively reorienting trajectories of physical function among survivors. Methods of the RENEW trial have been published previously (16, 17). The Institutional Review Board at the Duke University Health System and the North Carolina Central Cancer Registry (NCCCR) approved the research protocol and all participants provided written informed consent. Participants for RENEW were recruited from July 1, 2005 to May 17, 2007 through the NCCCR, the Duke Cancer Registry, and previously established physician referral networks, described in detail elsewhere (18).

The following eligibility criteria were applied at the time of case ascertainment or screening: 1) age ≥ 65 years; 2) ≥ 5 years beyond the diagnosis of breast, prostate, or colorectal cancer with no evidence of progressive disease or second cancers; 3) approved for contact by their oncologist; 4) English-speaking and writing; 5) no contraindications to unsupervised exercise (e.g., angina, myocardial infarction within 6-months, congestive heart failure, chronic obstructive pulmonary disease, plans to have a hip or knee replacement, walker or wheelchair-use, recent stroke with hemiparesis) or a diet high in fruits and vegetables (e.g., renal insufficiency); 6) residence within the community; and 7) overweight (BMI ≥ 25), but not morbidly obese (BMI < 40) as these individuals may have required a supervised exercise program.

We excluded survivors who resided outside of the United States (*n* = 3) and those who reported implausible dietary energy intakes (< 500 kcal or > 5,000 kcal) (*n* = 6) (19, 20) for the present analysis. Based on this criterion, the analytic sample included 729 survivors of breast (n = 308), prostate (n = 312), and colorectal (n = 109) cancer.

Data Collection

Demographic and medical data, including cancer type, cancer stage, date of diagnosis, age, race, and sex, were provided by the registry databases and oncologists. All survivors included in the present analysis completed an initial written screening assessment and underwent two 45–60 minute telephone interviews administered by the Diet Assessment Center at the Pennsylvania State University.

Physical activity was assessed using the Community Health Activities Model Program for Seniors (CHAMPS) questionnaire (21) during the telephone interview. Smoking status and self-reported height and weight, used to calculate BMI, were collected during the telephone surveys. Rural or urban residence was determined through the use of Rural-Urban Commuting Area Codes (RUCA version 2.0), a Census tract-based classification scheme that utilizes the Bureau of Census Urbanized Area and Urban Cluster definitions and work-related commuting data to characterize ZIP codes within the United States (22).

Dietary Assessment and Identification of Dietary Patterns

Dietary intake data were collected during the screening process for the RENEW trial during the two telephone surveys by 24-hour dietary recalls using the interactive Nutrition Data System for Research (NDSR) software (Version 2006, Nutrition Coordinating Center, Minneapolis, MN) (23). The two dietary recalls were conducted between July 1, 2005 to May 17, 2007 by trained interviewers at Pennsylvania State University's Diet Assessment Center. The dietary recalls were performed on unannounced, non-consecutive days (one weekend day and one weekday) by using a multiple-pass interview methodology that provides repeated opportunities for respondents to recall their dietary intake from the previous day (midnight to midnight). Respondents were provided with food portion estimation visual aids before the interviews to assist in portion size estimation. Each dietary recall ranged from 15 to 30 minutes.

Single food items were aggregated into predefined food groups based on similarity of nutrient content, culinary use, or potential relevance to cancer etiology (Appendix 1). Individual food or beverage items were preserved if they were thought to represent distinct dietary behaviors or if they had a unique nutrient profile. To account for right-hand skewed distributions and zero intakes, the food group and food item intakes were logarthmically transformed after a constant was added to all observations. Principal Components Analysis (PCA) was performed on mutually-exclusive food groups and food items separately for rural and urban residents with the Proc Factor command in SAS (version 9.2, SAS Institute, Inc., Cary, North Carolina) to identify dietary patterns. An orthogonal (varimax) rotation procedure was used to ensure the factors were uncorrelated and to obtain a simpler structure with greater interpretability (24).

Three principal components (i.e., dietary patterns) for both urban and rural survivors were retained after consideration of eigenvalues (> 1.5), the Scree test, and interpretability (24). The dietary patterns and their factor loadings are shown in Table 2. A positive factor loading indicates that the food group is positively associated with the pattern, whereas a negative loading indicates an inverse association. Factor scores were created for participants by summing intakes of food groups weighted by their factor loadings for each of the identified components.

STATISTICAL ANALYSIS

Characteristics of rural and urban cancer survivors were compared with *t* tests for normally distributed continuous variables, Wilcoxon rank sum tests for non-normally distributed continuous variables, and χ^2 tests for categorical variables. Multivariate-adjusted general linear models were used to test the association of dietary patterns scores, categorized into distribution-based quintiles, and BMI. Multivariate-adjusted means and standard errors (SE) of BMI for each quintile of dietary pattern scores, stratified by residence, were obtained with the general linear models. Age (y) and total energy intake (kcal/day) were chosen *a priori* for inclusion in the models. Other potential confounders were considered for inclusion in multivariate general linear models, including sex; tumor stage (localized, regional, and unknown); educational attainment (% any college); smoking status (% current smoker); physical activity (minutes/week of moderate-to-vigorous activity); cancer type (breast, prostate, or colorectal); number of comorbidities; and race (non-Hispanic white, African-American, and other/unknown). Alcohol intake was not considered as a potential confounder because it was an input variable in the PCA.

The final general linear models included the covariates that resulted in a 10% change in the effect estimate of one of the dietary pattern variables, holding the other variables constant, in addition to age and total energy intake. Based on this criterion, sex, total energy intake, educational attainment, and physical activity (minutes/week of moderate-to-vigorous activity) were retained. The final models were evaluated for satisfaction of underlying statistical assumptions. Linear trend tests (*p* for trend) were calculated by entering each factor as a continuous variable in the multivariable models.

RESULTS

Characteristics of rural and urban cancer survivors are presented in Table 1. Significant differences in educational attainment and total energy intake were observed. Urban survivors had higher educational attainment ($p < 0.001$) and mean total energy intake ($p < 0.05$) compared to their rural counterparts. Age, sex, racial distribution, cancer type, cancer stage, number of comorbidities, tobacco use, BMI, and physical activity did not differ significantly between urban and rural dwellers.

PCA identified three dietary patterns among rural dwellers (“high sweets and starches”, “high reduced fat-fat dairy, cereal, fruits, and nuts”, and “mixed”) and three among urban dwellers (“high fruit and vegetables”, “high meat, beer, and refined grains”, and “high sugar-sweetened beverages”). The factor loadings for each pattern are shown in Table 2. The “high sweets and starches” pattern among rural residents was characterized by greater intakes of sweet tea, other sugar-sweetened beverages, white potatoes, vegetable oil, sweet breads and cakes, other starchy vegetables, confectionary and other sweets, and poultry, and lower intakes of sugar-free beverages. Greater intakes of low-fat dairy, ready-to-eat cereal, nuts and seeds, whole fruits, and whole grains and low intakes of fried potatoes, red meat, refined grains, and eggs composed the “high reduced-fat dairy, cereal, fruits, and nuts” pattern. The “mixed” pattern among rural residents was characterized by higher intakes of eggs, fried potatoes, mayonnaise and mayonnaise-based dressings, margarine, salty snacks, legumes, poultry, and vegetables, and lower intakes of fish and wine. Increasing scores on the “high reduced-fat dairy, cereal, fruits, and nuts” pattern, reflecting greater adherence to this diet, was inversely associated with BMI in univariate analyses ($p = 0.012$) (data not

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shown). No significant associations between scores on the other two patterns and BMI were found in univariate analyses.

Among urban dwellers, the “high fruits and vegetables” pattern reflected greater intakes of fruits, vegetables, low-fat dairy, ready-to-eat cereal, nuts and seeds, mayonnaise and mayonnaise-based dressings, and lower intakes of eggs. The “high meat, beer, and refined grains” pattern among urban dwellers was characterized by greater intakes of red meat, refined grains, beer, high-fat dairy, butter, eggs, and vegetable oil and lower intakes of whole fruits. With the “high sugar-sweetened beverages” pattern, sweet tea, other sugar-sweetened beverages, and starchy vegetables loaded very strongly onto this factor, whereas coffee was negatively correlated with this pattern. Increasing scores on the “high fruits and vegetables” pattern was significantly associated with lower BMI in univariate analyses ($p = 0.005$) (data not shown). No significant correlations between scores on the other two patterns and BMI in univarate analyses.

Table 3 presents results from the multivariable general linear models used to estimate the independent effects of dietary pattern scores on BMI. Among rural survivors, greater adherence to the “high reduced-fat dairy, cereal, fruits, and nuts” pattern was inversely associated with BMI after multivariate adjustment (p-trend < 0.05) whereas increasing scores on the “mixed” pattern were positively associated with BMI (p-trend < 0.05). In addition, greater adherence to the “high fruits and vegetables” pattern among urban survivors was positively associated with BMI after multivariate adjustment (p-trend < 0.05).

DISCUSSION

Results from the present study support our hypotheses that dietary patterns differ in composition between rural and urban older adult cancer survivors. Our findings also suggest that dietary patterns are associated with BMI among overweight survivors. This analysis provides insight into dietary differences that may serve useful in designing future public health interventions. For example, alcohol did not load positively onto the rural dietary patterns whereas beer did load positively onto the “meat, beer, and refined grains” pattern among urban dwellers. Greater intake of refined grains, rather than whole grains, was a significant component of one of the urban patterns (“high meat, beer, and refined grains”) but was not present in the rural patterns. In contrast, greater intakes of whole grains contributed to the rural “high reduced-fat dairy, cereal, fruits, and nuts” pattern whereas lower intakes were represented in the urban “high meat, beer, and refined grains” pattern. Red meat positively loaded onto the “high meat, beer, and refined grains” pattern among urban survivors but negatively loaded onto the “high reduced-fat dairy, cereal, fruits, and nuts” among rural residents. Another notable difference was that sweets, which included pastries, doughnuts, cakes, and candy, were significant contributors to the rural “high sweets and starches” pattern but did not contribute to any of the three patterns among urban survivors. One important similarity between urban and rural dwellers was the high factor loadings of sugar-sweetened beverages on the urban “high sweets and starches” pattern and the rural “high sugar-sweetened beverages” pattern.

Research into dietary patterns by geographic location in the U.S. is lacking, although differences in dietary intake between urban and rural residents have been observed in studies outside of the U.S. (25, 26). A number of factors may explain observed discrepancies in food choices and dietary intake, including differences in socioeconomic status (27, 28) and food accessibility (29). Rural residents tend to have lower levels of educational attainment, higher levels of poverty, and fewer resources, including access to supermarkets (30, 31), compared to their urban counterparts (12). Indeed, rural survivors had significantly lower levels of education compared to urban survivors in our study (58% versus 66% had some college education, respectively), which may have contributed in part to the observed differences in dietary intake patterns. The pattern that explained the largest proportion of the variation in dietary intake among rural survivors was a “high sweets and starches” pattern compared to a “high fruits and vegetables” pattern that explained the largest proportion of the variation among urban survivors. In addition, although one rural pattern (“high reduced-fat dairy, cereal, fruits, and nuts”) included comparatively greater intakes of fruit and a second pattern (“mixed”) included relatively greater intakes of vegetables, the “high fruits and vegetables” pattern among urban residents was composed of comparatively greater intakes of both fruits and vegetables.

In recent years, overweight, obesity, and post-diagnosis weight gain have come to be recognized as important contributors not only to risk of cancer recurrence (32–34) but also to death among cancer survivors (32, 33, 35). In a multicenter randomized clinical trial of adjuvant chemotherapy among colon cancer patients (34), a BMI greater than 35 kg/m^2 at diagnosis was associated with a significantly increased risk for recurrence. Significant trends between increasing BMI and death from colorectal, breast, and prostate cancer, among other cancer sites, were reported in the Cancer Prevention Study II, a prospective cohort of more than 900,000 adults followed for 16 years (35). Among 5,204 breast cancer survivors followed for a median of nine years in the Nurses’ Health Study, weight gain post-diagnosis was associated with significantly higher rates of breast cancer recurrence and mortality (33). Therefore, reducing excess weight and preventing unintentional weight gain are important goals for cancer survivors.

Findings from our study as well as others (14, 15) support an important role of dietary patterns on weight status. Dietary patterns characterized by greater intakes of fruits and vegetables, and often higher consumption of whole grains, low-fat dairy products, fish, poultry, non-hydrogenated fat, legumes, and nuts, have been associated with reduced BMI (14, 15). Results from our study were in accordance with these earlier reports from Murtaugh et al. and Paradis et al., as greater adherence to the “high reduced-fat dairy, cereal, fruits, and nuts” pattern among rural survivors and the “high fruits and vegetables” pattern among urban survivors were associated with lower BMI. On the other hand, higher scores on dietary patterns characterized by greater intakes of red and processed meat, high-fat dairy foods, refined grain products, fast food, pizza, fried potatoes, high-fat condiments and sauces, margarine, grain-based snacks, high-fat dairy foods, high-fat/high-sugar desserts, and sugar-sweetened beverages were associated with greater BMI in these previous studies (14, 15). Although the “high meat, beer, and refined grains” pattern identified in our study most closely resembles this western-style pattern described in these two earlier reports, it was not associated with higher BMI. A “mixed” dietary pattern, however, which contained some of the components identified in the western-style pattern (e.g., fried potatoes, high-fat condiments, margarine, and salty snacks), however, was significantly associated with higher BMI among rural residents.

In addition to the role of dietary patterns on weight status, previous studies have found dietary patterns to be significantly associated with a number of health outcomes, including cardiovascular disease (36–38), diabetes (38–40), metabolic syndrome (41), and certain cancers (42–45), after controlling for BMI or waist circumference. In the majority of these studies (36–38, 40–42, 45), greater adherence to more prudent dietary patterns that shared many similarities with the “high reduced-fat dairy, cereal, fruits, and nuts” and “high fruits and vegetables” patterns in our study, was associated with reduced disease risk. In contrast, higher scores on more western-style dietary patterns (comparable to the “high meat, beer, and refined grains” pattern identified among urban survivors in our study) were associated with increased disease risk (36–39, 41–43, 45).

In the present study, prevalence of obesity was marginally higher among rural compared to urban survivors (42.7% v. 35.9%; $p = 0.072$), which is a trend supported in the literature (13). It is possible that differences in dietary intake behavior based on geographic residence may be one mechanism by which obesity prevalence differs between these groups, although further investigation of this hypothesis is warranted. It is important to note that the observed difference in obesity prevalence in our study should be interpreted with caution given the inclusion criterion for participation [being overweight (BMI ≥ 25), but not morbidly obese (BMI < 40)]; thus, the range of BMI values and our ability to detect a true difference were limited.

The strengths of this study include the large and geographically-distributed sample of older adult cancer survivors (an understudied population), the comprehensive nature of the interviews, and the dietary assessment method of interviewer-administered 24-hour recalls on more than one day, which is considered the gold standard for self-reported dietary intake data collection (46). The interviewer-administered 24-hour recall allows for the collection of detailed food and portion size data and does not affect food choices on a given day, in contrast to food records, since data are collected after consumption. Therefore, multiple day 24-hour recalls are thought to produce the least biased and highest quality self-reported dietary intake data. Several limitations of the present study, including respondent and sampling biases, reliance on self-report measures, and the cross-sectional design, should also be considered. Significantly higher response rates were noted among survivors who were Caucasian, younger, and more proximal to diagnosis, as well as breast cancer survivors (16), which limits the external generalizability of the findings. Generalizability may have been further limited by the eligibility criteria that excluded individuals with an active lifestyle, significant comorbidities, and normal weight or morbid obesity. Dietary patterns have been shown to differ by race (47); however, our predominately Caucasian sample (89%) may have limited our ability to detect dietary patterns unique to different racial groups. Although potential confounders were considered and included in the multivariable models, residual or unknown confounding remains possible.

CONCLUSION

Three distinct dietary patterns emerged for both rural and urban survivors, indicating different food intake patterns between groups. These differences in dietary intake patterns should be considered when designing public health interventions targeting diet modification and weight management to reduce the risk of obesity and other chronic diseases among the increasing population of older, long-term cancer survivors. Continued research efforts are needed to identify how to best target dietary patterns to improve dietary compliance and to clarify the role of geographic location on both diet and obesity in this population. In addition, longitudinal research that examines the effect of dietary patterns, as well as change in dietary patterns, on BMI and other health-related endpoints would greatly extend the current findings.

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Table 1

Selected characteristics among overweight, long-term (> 5y), older rural and urban cancer survivors

Characteristic	Rural (n = 241)	Urban (n = 488)
	Mean ± SD (Median)[a]	
Age (y)	73.0 ± 5.2	73.1 ± 5.0[b]
Comorbidities (no.)	1.9 ± 1.2	1.9 ± 1.3
Total energy intake (kcal/day)	1444 ± 476	1587 ± 491***
Moderate-to-vigorous physical activity (min/wk)	59.7 ± 114 (0)	61.6 ± 101 (15)
	%	
Sex (% male)	56.0	49.6
Race/ethnicity		
Non-hispanic white	88.0	89.8
African American	11.6	9.2
Other or unknown	0.4	1.0
Education (% any college)	58.1	65.6*
Cancer type		
Female breast cancer	45.6	40.6
Prostate cancer	38.6	44.9
Colorectal cancer	15.8	14.6
Cancer stage		
In situ or localized	68.5	70.3
Regional	27.0	26.4
Unknown	4.6	3.3
Body mass index		
Overweight (25–29.9 kg/m^2)	57.3	64.1
Obese (30–39.9 kg/m^2)	42.7	35.9
Tobacco use (% current smoker)	7.9	5.3

[a]The median is presented for physical activity since it is non-normally distributed (large right-hand skew)

[b]*P*-values for differences in means were calculated with *t* tests for normally distributed variables and Wilcoxon rank sum tests for non-normally distributed variables. Differences in proportions were calculated with χ^2 tests.

*$P < 0.05$,

***$P < 0.001$

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Table 2

Factor loadings of food groups in the dietary patterns derived from principal components analysis[a,b]

Food item or group[c]	Rural Residence (n = 241)			Urban Residence (n = 488)		
	High sweets and starches	High reduced-fat dairy, cereal, fruits, and nuts	Mixed	High fruits and vegetables	High meat, beer, and refined grains	High sugar- sweetened beverages
Sweet tea	67	–	–	–	–	84
Sugar-sweetened beverages	63	–	–	–	–	83
White potatoes	49	–	–	–	–	–
Vegetable oil	37	–	–	–	28	–
Sweet breads/cakes	31	–	–	–	–	–
Starchy vegetables	29	–	–	–	–	35
Confectionary/other sweets	27	–	–	–	–	–
Poultry	25	–	27	–	–	–
Diet beverages	−45		–	–	–	–
Low-fat dairy	–	60	–	38	–	–
Ready-to-eat cereal	–	49	–	31	–	–
Nuts and seeds	–	49	–	36	–	–
Whole fruits	–	48	–	46	–	–
Whole grains	–	29	–	–	−53	–
Fried potatoes	–	−32	32	–	–	–
Red meat	–	−37	–	–	42	–
Refined grains	–	−48	–	–	59	–
Eggs	–	−25	51	−35	35	–
Tomatoes	–	–	53	56	–	–
Legumes	–	–	52	39	–	–
Margarine	–	–	43	–	–	–
Dressings	–	–	42	47	–	–
Deep yellow vegetables	–	–	31	30	–	–
Dark green vegetables	–	–	30	39	–	–
Salty snacks	–	–	29	–	–	–
Wine	–	–	−33	–	–	–

Food item or group[c]	Rural Residence (n = 241)			Urban Residence (n = 488)		
	High sweets and starches	**High reduced-fat dairy, cereal, fruits, and nuts**	**Mixed**	**High fruits and vegetables**	**High meat, beer, and refined grains**	**High sugar- sweetened beverages**
Fish	–	–	−26	–	–	–
Beer	–	–	–	–	41	–
Processed meat	–	–	–	–	34	–
High-fat dairy	–	–	–	–	30	–
Butter	–	–	–	–	26	–
Coffee	–	–	–	–	–	−28

[a] Factor loadings are the correlation coefficients (*r*) between the original food intake variables and the extracted factors.

[b] Factor loadings ≤ |0.25| are omitted from this table for simplicity.

[c] A description of the food items included in each food group is provided in Appendix 1.

Table 3

Multivariate-adjusted mean (SE)[a] of body mass index (BMI) by quintiles of dietary pattern scores among overweight, long-term (> 5y), older cancer survivors, stratified by geographic residence

Dietary Pattern	Quintile 1[a,b]	Quintile 2	Quintile 3	Quintile 4	Quintile 5	*P*-trend[c]
Rural Residence (n = 241)						
High sweets and starches	29.7 (0.50)[d]	29.9 (0.51)	29.1 (0.48)	28.5 (0.50)	29.2 (0.52)	0.313
High reduced-fat dairy, cereal, nuts, and fruit	30.2 (0.49)	28.9 (0.48)	29.2 (0.49)	29.4 (0.49)	28.6 (0.51)	0.023
Mixed	28.4 (0.50)	29.1 (0.48)	28.7 (0.50)	29.5 (0.50)	30.6 (0.52)	0.011
Urban Residence (n = 488)						
High fruits and vegetables	29.7 (0.32)	28.7 (0.32)	28.9 (0.32)	28.6 (0.32)	28.6 (0.33)	0.040
High meat, beer, and refined grains	28.6 (0.33)	29.4 (0.32)	28.6 (0.32)	29.2 (0.32)	28.5 (0.35)	0.866
High sugar-sweetened beverages	28.4 (0.32)	29.1 (0.32)	29.2 (0.32)	29.3 (0.32)	28.5 (0.31)	0.590

[a] Quintiles are in ascending order of dietary pattern scores.

[b] The range of scores per quintile are as follows: "high sweets and starches," quintile 1(−2.43 to −0.66), quintile 2 (−0.65 to −0.29), quintile 3 (−0.28 to 0.05), quintile 4 (0.06 to 0.52), quintile 5 (0.55 to 5.64); for "high reduced-fat dairy, cereal, nuts, and fruit," quintile 1 (−2.78 to −0.81), quintile 2 (−0.80 to −0.32), quintile 3 (−0.31 to 0.13), quintile 4 (0.14 to 0.65), quintile 5 (0.65 to 3.66); for "mixed," quintile 1 (−2.95 to −0.73), quintile 2 (−0.72 to −0.36), quintile 3 (−0.35 to 0.06), quintile 4 (0.07 to 0.66), quintile 5 (0.67 to 5.56); for "high fruits and vegetables", quintile 1 (−2.11 to −0.83), quintile 2 (−0.81 to −0.34), quintile 3 (−0.33 to 0.07), quintile 4 (0.07 to 0.85), quintile 5 (0.86 to 6.51); for "high meat, beer, and refined grains", quintile 1 (−2.64 to −0.84), quintile 2 (−0.83 to −0.28), quintile 3 (−0.27 to 0.16), quintile 4 (0.17 to 0.69), quintile 5 (0.70 to 4.00); and for "high sugar-sweetened beverages", quintile 1 (−1.81 to −0.61), quintile 2 (−0.60 to −0.34), quintile 3 (−0.35 to −0.05), quintile 4 (−0.04 to 0.45), quintile 5 (0.46 to 5.90).

[c] *P* for trend values were derived from linear trend tests where each factor was entered separately into multivariable linear regression models.

[d] Means were adjusted for age, sex, total energy intake (kcal/day), education attainment (% any college), and physical activity (minutes/week of moderate to vigorous activity).

Appendix 1

Description of food groups explored to derive dietary patterns in the principal components analysis

Food group	Food items
Sweet tea	Sweetened hot and iced tea
Sugar-sweetened beverages	Sugar-sweetened soft drinks, fruit drinks (not 100% juice), and water
White potatoes	White potatoes (not fried)
Diet beverages	Artificially-sweetened soft drinks, fruit drinks, and water
Sweet breads/cakes	Cakes, cookies, pies, pastries, Danish, doughnuts, and cobblers
Vegetable oil	–
Confectionary/other sweets	Candy, sugar-sweetened sauces and syrups (e.g., chocolate and butterscotch), frostings
Starchy vegetables	Corn, lima beans, lentil spouts, peas
100% fruit juice	–
Low-fat dairy	Fat-free and low-fat (1%) milk, cheese, yogurt
Nuts and seeds	–
Whole fruits	–
Tomatoes	Tomatoes in mixed dishes, sauces, soups, and 100% juice
Ready-to-eat cereal	–
Refined grains	Corn meal, pearled barley, rye flour, wheat flour, white rice, refined grain pasta
Dark green vegetables	Broccoli, collards, romaine, spinach, etc.
Whole grains	Brown rice, cracked wheat, oatmeal, whole grain corn meal, whole rye meal, whole wheat flour, whole wheat pasta
Fried potatoes	French fries, hash browns, pan fried potatoes, fried potato skins
Eggs	–
Dressings	Salad dressings, mayonnaise, and mayonnaise-type dressings
Legumes	Mature lima beans, refried beans, baked beans, etc.
Margarine	Regular and reduced fat
Deep yellow vegetables	Carrots, winter squash, sweet potatoes, pumpkin, etc.
Processed meat	Cured pork, cold cuts, sausage, etc.
Coffee	–
Salty snacks	Potato chips, pretzels, canned onion rings, snack chips, crackers, popcorn
Beer	–
Wine	–
Liquor	–
High-fat dairy	Whole and 2% fat milk, cheese, yogurt, cream; frozen dairy desserts, puddings, cream-based sauces
Red meat	Beef, lamb, veal, game, organ meats, pork
Butter	Regular and reduced fat
Fish	–
Gravy	–