Mixed Method Approaches to Understanding Cancer-Related Dietary Risk Reduction among Public Housing Residents

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ABSTRACT *Improving diet is one important pathway for addressing cancer disparities. We conducted mixed-method analyses of 468 24-h dietary recalls from 156 African-American women residents of Washington DC public housing to better understand dietary patterns. Recalls were rated for five cancer-related preventive characteristics (adequate fruits/vegetables, moderate fat, moderate calories, no alcohol, and adequate Healthy Eating Index score), combined as a scale. Bivariate and multivariate analyses identified psychosocial and dietary characteristics associated with scale scores. Qualitative analyses of dietary records identified contextual aspects of food patterns within and across score groups. Sixty-one percent of respondents met zero or one dietary goal; alcohol abstention was most common (64%). Only 12% achieve either three (6%), four (4%), or all five (<1%) goals; five fruit and vegetable servings were least common (15%). The underlying scalar structure of responses suggests that fruit and vegetable consumption is seldom achieved in this population without other scale components. Poorer scores were associated with younger age, depressive symptoms, stressful life events, smoking, and food-purchasing practices. Qualitative analyses identified eight themes related to differences between dietary patterns. Findings reinforce the value of nonreductionist approaches to cancer-related nutrition intervention.*

KEYWORDS *Cancer, Nutrition, Prevention, African-American, Women, Qualitative methods, Disparities, Urban health*

INTRODUCTION

Despite improved understanding of etiology and progression and new technologies for detection and treatment, cancer disparities continue to grow, and overall burden falls most heavily, in both developing and industrialized countries, on those with fewer resources.^{1,2} Social gradients in cancer burden, both within and across societies, stem from multiple sources, with one important influence being diet. Strong evidence links dietary behaviors, established early in life and maintained over

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the life course, to risk for cancer and other chronic diseases, with one third of cancers attributed to diet.^{3,4} Specific controversies notwithstanding, consensus suggests that cancer risk is reduced through moderate caloric intake, a varied diet of primarily plant-based foods, and reduced consumption of energy-dense foods (including those high in fats), alcohol, sodium, and processed meats.^{4,5}

Nutrition disparities are growing more complex, due in part to the worldwide nutrition transition.⁶ Low-resource populations no longer suffer just from barriers of access to healthful foods but also from inability to control caloric intake and achieve healthful energy balance. These growing disparities in diet and energy imbalance will further exacerbate cancer disparities, thwarting efforts at global cancer control.⁷ For example, although the majority of Americans do not consume recommended amounts of fruits and vegetables, risk for underconsumption is significantly greater for ethnic minorities, persons living in poverty, and those with less than a high school education.⁸

Dietary behavior change campaigns often focus on a single behavior—such as the well-known “Five-a-Day for Better Health,” promoting five servings of fruits and vegetables.⁹ There is incomplete understanding, however, of how single dietary messages are incorporated into daily food routines or how best to help at-risk populations change their overall eating patterns.

Understanding and intervening in nutrition requires multilevel perspectives and approaches. Diets are composed not just of individual nutrients but of foods, combinations of foods in meals, and patterns of eating events across time. Similarly, individuals obtain, prepare, and consume foods in social units of households, families, and communities. Because elements of diet are interrelated, contextually based explorations of dietary behaviors balance “reductionist” emphasis on individual nutrients.^{10,11}

This work focuses on African-American women living in urban public housing communities. Low-income urban African-American women bear a significant burden from poor nutrition, energy imbalance, and nutrition-related chronic diseases, including cancer.^{12–15} Their behaviors additionally shape the food culture within their households; thus, they are potential change agents for others.¹⁶

We designed and implemented a small-group empowerment model nutrition education intervention to increase fruit and vegetable consumption among women residents of Washington DC public housing. Adherent participants made meaningful dietary changes, reducing both total calories and percent calories from fat but no increase in fruit and vegetable consumption.¹⁷ This led us to ask how we can best understand relationships between the individual dietary elements that comprise cancer-related dietary risk.

Our goal here is to use a mixed-method approach to examine cancer-risk-related dietary patterns among a low-resource population, using dietary reports and survey responses collected at baseline from intervention participants. Mixed methods can serve many research goals; here, their strength is in facilitating a comparative analysis strategy.¹⁸ First, we separately conduct both quantitative and qualitative analyses of dietary content and then, through synthesized interpretation of the results, triangulate and extend our conclusions. To our knowledge, this is a novel approach to the interpretation of diet through 24-h recalls.

We examine the co-occurrence of specific cancer-related dietary characteristics to determine if a single underlying construct, capturing cancer-related dietary behavior, was exhibited in respondents’ habitual diet. Qualitative ethnographic textual analysis of dietary records was used to identify contextual aspects of food

patterns across cancer risk groups, such as timing and composition of eating events. By understanding social and environmental correlates of dietary patterns within high-risk groups, we can better design and implement strategies to improve diet.

METHODS

Setting and Population

From 2000 to 2005, with funding from the American Cancer Society, we designed and implemented a seven-session small-group nutrition education intervention with women aged 20–50, residing in 11 public housing communities in southeast and northeast Washington DC. Information on program design, content, and results is published elsewhere.^{17,19–22} With input from the Housing Authority and community residents, we recruited 18 cohorts across a 28-month intervention period, with an average of ten women (range 5–17) per cohort. Participant demographics mirrored 2000 Census description of these communities as 97% African–American, 75% female-headed households with children <18, 58% adult high school completion, and \$21,130 median household income (www.Census.gov).

Participants were self-identified African–Americans with US born parents and grandparents, who were not pregnant, lactating, on medical-prescribed diets, or disclosing significant drug or alcohol abuse. Participants gave informed consent before eligibility screening and enrollment and were compensated for data collection but not participation.

Data were collected during in-person interviewer-administered sessions in community centers or respondent homes. At baseline, interviewers collected three computer-assisted nonconsecutive 24-h dietary recalls (two weekdays/one weekend), across 21 days, using Nutritional Data Systems for Research (NDS-R) version 4.03.31 (University of Minnesota Nutritional Coordinating Center, Minneapolis, MN, USA). All persons involved in recall data collection and management were trained and certified and also annually recertified in NDS-R data collection by NDS-R staff.

A 60-min questionnaire collected sociodemographics, family composition, physical and mental health, and diet-related attitudes, knowledge, and behaviors. Instruments, developed from our own or others' surveys of urban African–Americans, were pilot-tested on nonparticipating community residents. Participant height and weight were measured with portable digital instruments.

Program evaluation included 187 women completing screening and informed consent and providing one or more baseline recalls.¹⁷ Here, we use the subgroup ($n=156$) completing full baseline measurement, including height and weight.

Measures Used in These Analyses

Dietary Measures NDS-R software calculates foods, food types, nutrients, and timing and number of meals. We also qualitatively analyzed 24-h recalls as textual documents.

We calculated five specific cancer prevention dietary variables by averaging the three recalls and scoring respondents either 0 or 1 for: no alcoholic beverage intake (excluding food sources), moderate caloric intake (1,600–2,200 cal), moderate fat intake (<30% of calories), 5+ servings of fruits and vegetables, and ≥ 65 on the Healthy Eating Index (HEI), a US Department of Agriculture (USDA) measure of

dietary quality.²² These five 0/1 values were also summed as a cancer prevention index.

Following Five-A-Day guidelines, we included NDS-R categories of citrus and noncitrus fruits, dark green and yellow vegetables, tomatoes, legumes, other vegetables, fried vegetables, and fruit and vegetable juices but not fried fruits, white potatoes, fried potatoes, or fruit or vegetable savory snacks. The HEI combines scores of 0–10 on ten dietary indicators: variety, low sodium, cholesterol, percent fat and saturated fat, and adequate meat, dairy, grains, vegetables, and fruits, with 65 being the US median value.²³

Nondietary Measures We used respondent-reported age, birthplace, and an abbreviated Centers for Epidemiologic Studies Depression index,²⁴ capturing depressive symptoms in the past week. We measured 11 stressful events in the past year (own loss of job, income, residence, partner, or child custody, own or someone close's experience of violence, arrest/legal trouble, illness, HIV+ diagnosis, substance abuse, or death of someone close) and dichotomized the summed totals (range 0–10) into 3+ versus 0–2. Body mass index (BMI) was calculated as (weight in pounds/(height in inches squared)) $\times$ 703. Respondents reported their current smoking status, frequency of 20+ min of physical activity, and anticipated future health as better, the same, or worse. Four items measured food behaviors: food stamps, nonpurchased food (WIC, food banks), usual transportation for food shopping, and menu planning before shopping. We also asked if respondents believed that specific foods could prevent cancer.

The intervention was designed to enroll women and collect data evenly across a 2.5-year period. Our previous analyses have tested for but found no effects of seasonality in these data. Therefore, we did not include season in these analyses.

Data Analysis

We examined univariate frequencies of each cancer-related dietary variable and the summed score. Response patterns were tested for scalability as a Guttman scale,²⁵ with graduated intensity in the underlying construct of cancer-related dietary behaviors. This tests the degree to which scale items with binary responses can be ranked to capture a response pattern such that a respondent who scores positively on any given item can also be assumed to have scored positively on all lower ranked items. The coefficient of reproducibility ($1 - (\# \text{ errors} / (\# \text{ responses} \times \# \text{ respondents}))$) tests how often summed index scores accurately represent 0/1 responses on specific items; values ≥ 0.90 indicate strong scalar relationships.

Next, we investigated bivariate and multivariate relationships between scale scores and psychosocial, health and food-related characteristics (Table 1), and bivariate relationships between nutrients and micronutrients, servings of food types, and patterns of daily food intake, including location, timing, and size of meals (Table 2). Our goal was to identify individual aspects of diet on which women vary, leading to differences seen in the five cancer prevention measures. In this exploratory process, we examined a larger number of food-related variables but focus here on dietary elements which differ, as well as those expected to differ, and thus lack of difference is noteworthy.

We compared values of psychosocial or food variables for women scoring 0 on the scale to those scoring 1, 2, or 3–5 (combined due to few women scoring 4 or 5). In Table 1, we report results from ordinal logistic regression models, estimating the odds of a one unit increase in scale score associated with each independent variable

TABLE 1 Respondents' cancer prevention diet score by selected characteristics (*n*=156) crude and adjusted odds of one unit increase in score, ordinal logistic regression

		Unadjusted		Adjusted	
	Number	Odds ratio	95 % CI	Odds ratio	95% CI
Psychosocial measures					
Age					
20–29	81	1.00	Reference	1.00	Reference
30–39	75	1.41	(0.59, 3.34)	2.00	(0.78, 5.11)
40–50		2.02	(0.89, 4.59)*	2.72	(1.10, 6.73) **
Place of birth					
Elsewhere	115	1.00	Reference		
In Washington DC	41	0.53	(0.27,1.03)*		
CES-D symptoms					
None	37	1.00	Reference	1.00	Reference
Any	116	0.51	(0.25, 1.04)*	0.45	(0.22, 0.95)**
Stressful life events					
0–2	44	1.00	Reference	1.00	Reference
3–10	112	0.44	(0.23, 0.84)**	0.49	(0.34, 0.98)**
Health measures					
Body mass index					
18–29	78	1.00	Reference		
30–39	47	1.54	(0.79, 3.00)		
40–63	29	2.11	(0.95, 4.68)*		
Current smoker					
No	61	1.00	Reference	1.00	Reference
Yes	95	0.33	(0.18, 0.61)***	0.28	(0.14, 0.56) ***
Expectations for future health					
Same or worse	70	1.00	Reference	1.00	Reference
Better	86	1.74	(0.96, 3.16)*	1.76	(0.93, 3.33)*
Exercises 1+ times per week					
No	94	1.00	Reference		
Yes	59	1.74	(0.94, 3.21)*		
Food-related behaviors					
Receives food stamps					
No	51	1.00	Reference		
Yes	104	0.53	(0.28, 1.00)*		
Receives food from other sources					
No	74	1.00	Reference	1.00	Reference
Yes	82	0.63	(0.35, 1.12)	0.56	(0.30, 1.07)*
Travels to grocery store					
On foot, borrows car, gets a ride	106	1.00	Reference	1.00	Reference
In own car, or with public transport	50	2.11	(1.13, 3.94)**	1.94	(1.00, 3.79)*
Plans meals before shopping					
Seldom, never	48	1.00	Reference	1.00	Reference
Some of the time	49	1.55	(0.75, 3.20)	1.57	(0.72, 3.44)
Most of the time	59	1.91	(0.93, 3.93)*	2.37	(1.09, 5.17)**

TABLE 1 (continued)

	Number	Unadjusted		Adjusted	
		Odds ratio	95 % CI	Odds ratio	95% CI
Certain foods reduce cancer risk					
No/do not know	78	1.00	Reference		
Yes	78	1.85	(1.02, 3.33)**		

Odds associated with a one unit increase in score (0 vs. 1 vs. 2 vs. 3–5; scores of 3 to 5 combined due to small numbers), from ordinal logistic regression models. Adjusted model reports odds ratios from a final most parsimonious model, containing eight independent variables shown (age, depression, life events, smoking, expected future health, food from other sources, shopping transportation, and meal planning)
p*<0.10, *p*<0.05, ****p*<0.01

category of interest. The first set of results in Table 1 reports unadjusted or crude odds ratios for each independent variable. The second set reports the results of a multivariate ordinal logistic model. We built this model by considering all 13 possible covariates in Table 1 and then removing nonsignificant variables in a stepwise fashion and examining model fit. Given the modest total sample size, the final model retains all variables with marginal or greater statistical significance (*p*<0.10).

In Table 2, we used multilevel random intercept models to estimate the average daily value for each characteristic of interest in the reference group (women scoring 0) and the average change in value for a one unit increase in score (1, 2, 3+). The random intercept model accommodates the nested data structure (three 24-h recalls per participant), as well as variability inherent in diets, without restricting the underlying structure of that variation.^{26,27} We used SPSS generalized linear models for the ordinal regression modeling (SPSS Corporation, Chicago, IL, USA) and the generalized linear latent and mixed models extension of STATA for the random-effects modeling (Stata Corporation, College Station, TX, USA).

Qualitative Analysis

We used an ethnographic or contextual content analysis methodology to analyze the 24-h recalls as textual documents,²⁸ with the first two authors conducting all qualitative analyses. We used a memoing technique to first create case-based summaries and then used categorical coding to identify instances of specific thematic elements.

Our textual analysis began with review of recalls for women scoring 0 on the scale and women scoring 4 or 5 (*n*=31 women, 93 recalls). Next, we wrote descriptive summaries of participants’ diets, describing noteworthy aspects related to scale elements. To establish interpretive reliability between the two investigators, we each independently wrote descriptive summaries on sample recall sets, followed by discussion to reach consensus and reliability. From these summaries, a constant comparative process²⁹ identified key themes both within and between low- and high-scoring women. The qualitative analysis focused on multiple nested levels of information contained in each set of three recalls, with identified themes relating to one or more levels: (1) relationship of days to each other and overall food patterns across days, (2) each specific 24-h period, (3) each meal or eating event, and (4) each food, including preparation, portion size, and ingredients. A given woman or recall

TABLE 2 Average differences in dietary characteristics reported in 24-h recalls by cancer prevention diet index score, among public housing residents (*n*=156) random-effects linear regression models

	Index score of 0	Average difference	
	Average value	Per unit change (1, 2, 3–5)	<i>P</i> value
Eating event characteristics			
Number of eating events	4.1	−0.05	0.64
Hour of breakfast	9.6	−0.22	0.06
Calories at last event of day	592	−72	0.02
Grams of fat per event	28.7	−3	0.003
Grams of fiber per event	3.0	0.5	0.003
Percent of snacks as events	26	−3	0.09
Percent of events at friends' homes	7	−1	0.004
Percent of events at home	85	1	0.37
Daily servings of foods			
Dark green vegetables	0.34	0.20	0.02
Deep yellow vegetables	0.00	0.12	0.001
Tomatoes	0.24	0.03	0.39
Other vegetables	0.83	0.13	0.11
Citrus fruits	0.00	0.03	0.09
Other fruits	0.01	0.19	0.001
Citrus juices	0.09	0.23	0.002
Other fruit juices	0.02	0.09	0.04
Vegetable juices	0.02	−0.01	0.44
Milk	0.31	0.09	0.07
Diet soda	−0.03	0.07	0.02
Sweetened tea	0.12	0.16	0.02
Whole-grain breads	0.02	0.10	0.02
Cold cuts, sausage	0.37	−0.07	0.03
Cured pork	0.12	−0.04	<0.001
Daily nutrient intake (recommended daily value)			
Total calories	2,634	−158	0.08
Total fat (≤65), g	115	−13	0.002
Fiber (≥25), g	12	2	0.006
Protein (≤50), g	98	−6.5	0.06
Percent animal protein	77	−0.5	<0.005
Cholesterol (≤300), mg	464	−55	0.002
Sodium (≤2,400), mg	4,623	−352	0.01
Iron (≥18), mg	14.3	1.4	0.08
Vitamin A (≥5,000), IU	5,951	2,390	0.002
Vitamin C (≥60), IU	66.4	31.7	<0.001

Recommended daily values based on a caloric intake of 2,000 cal/day

could contain examples related to multiple themes. For example, a given eating event might contribute information to one theme due to its food content, to another based on its timing, and still another based on its contrast to another day's meals.

We present qualitative results through summary discussions of themes and visually displayed baseline recalls (Table 3) from three low-scoring and three high-scoring respondents to illustrate specific theme elements. These six were chosen purposively as showing diverse yet typical diets, without overemphasizing extremes.

TABLE 3 Examples of thematic textual comparison of 24 h recalls from respondents scoring 0 vs. 4 or 5 on cancer prevention scale

Scores of 0			Scores of 4 and 5 (#198)	
# 222			#198	
Day 1	3 p.m.	12-oz wine cooler	Day 1	8 a.m.
	4 p.m.	Three eggs with cheese/ham/tomato/onion, three tablespoons of applesauce		2 p.m.
	6 p.m.	12-oz beer	Day 2	8 p.m.
	7 p.m.	Two steak/cheese hot pockets, three cups of chips, one Baby Ruth, 1.5 cups of soda		10 a.m.
Day 2 ^a	12 p.m.	Two eggs, sausage, grits, cheese		1 p.m.
	5 p.m.	24-oz malt liquor		7 p.m.
Day 3	9 a.m.	1-cup OJ	Day 3 ^a	10 p.m.
	11 a.m.	1-cup OJ		11 a.m.
	5 p.m.	Ham-and-cheese sandwich		3 p.m.
	11 p.m.	Chicken sandwich, two cups of chips		4 p.m.
				8 p.m.
				10 PM
# 217			#163	
Day 1	10 a.m.	One-half cup of sunflower seeds	Day 1	9 a.m.
	12 p.m.	(Court) four corn chips		12 p.m.
	1 a.m.	Four cups of chicken rice soup, two cups of Kool-Aid		7 p.m.
	4 p.m.	Two cups of chicken soup, two cups of Kool-Aid		8 p.m.

Day 2	10 a.m.	Two cups of dry cereal	Day 2	8 a.m.	One scrambled egg, one cup of grits, two slices of turkey bacon, 1.5 cups of OJ
	11 a.m.	One Sloppy Joe, two cups of Kool-Aid, 4-oz brandy		1 p.m.	One-fourth pound of hamburger, one cup of mashed potatoes, one-half cup of mixed vegetables, one cup of cranberry juice
	12:30 p.m.	One Sloppy Joe, one cup of Kool-Aid, 2-oz brandy, one-half pack of candy		7 p.m.	Two cups of spaghetti with lean ground turkey sauce, three cups of tossed salad, one slice of garlic bread
	4 p.m.	One Sloppy Joe, two packs of oatmeal, one cup of Kool-Aid, 1.5-oz brandy		8 p.m.	One pastry
	9 p.m.	2.4-oz pork ribs, two slices of bread, 0.5-oz brandy			
Day 3 ^a	12 p.m.	One cup of Sloppy Joe, two cups of Kool-Aid	Day 3 ^a	10 a.m.	One scrambled egg, one-half cup of cooked apples, two slices of turkey bacon, one cup of cranberry drink
	2 p.m.	Two cups of Sloppy Joe, 1.5 slices of French toast, 3.5 cups of chips, four cups of Kool-Aid		1 p.m.	Two cups of tossed salad, one slice of cheese, tuna sandwich
	6 p.m.	Two cups of Sloppy Joe, 2-oz pork chop, 11-oz beer, four cups of Kool-Aid		8 p.m.	Frozen lasagna, one cup of spinach
	8 p.m.	Four cookies, one cup of Kool-Aid		10 p.m.	Three cups of sweet tea
# 39			# 194		
Day 1	10 a.m.	Two cups of grits with added tomato, four slices of bacon, four biscuits, two cups of tea	Day 1 ^a	7 a.m.	Crab cake, two cups of grits, one fried egg, one slice of wheat bread, one cup of OJ
	3 p.m.	20-oz malt liquor		1 p.m.	Turkey sandwich with tomato, one ice cream sandwich, three cups of Pepsi
	7:30 p.m.	Two cups of cooked peas, 1.5 biscuits, three cups of soda		8 p.m.	One-half cup of mixed veggies, two salmon croquettes, 1.5 cup of soda, one PB&J sandwich, one-half order KFC potato wedges, 5.5-oz KFC chicken breast, one lollipop
Day 2	11 a.m.	Two fried eggs, one cup of grits, four slices of bacon,	Day 2	7 a.m.	Two slices of scrapple, one scrambled egg, one-third cup of grits, one cup of OJ
	6 p.m.	(Church) six small Snickers, six Starbursts, nine small Reese's Cups, one-half cup of Kool-Aid		1 p.m.	One-half pork chop, one wheat roll, three cups of Pepsi
	8 p.m.	10-oz pork barbeque, two cups of lettuce, 1.5 cups of soda		5 p.m.	One-half cup of broccoli, 3.5 cups of spaghetti with beef sauce, one wheat roll, four slices of raw tomato

TABLE 3 (continued)

Scores of 0			Scores of 4 and 5 (#198)	
Day 3 ^a			Day 3	
12 p.m.	Three cups of French fries, two small chicken wings, two cups of sweet tea		9 a.m.	(Church) one-half cup of grits, one slice of scrapple, one scrambled egg, one cup of OJ
5 p.m.	Two cups of beef fried rice, one cup of greens, three biscuits, 1.5 cups of Kool-Aid		11 a.m.	(Church) one chicken thigh, one-half cup of rice with gravy, one-half cup of beans, two cups of fruit drink
10 p.m.	Two cups of mac and cheese, one 1cup of broccoli		6 p.m.	One chicken leg, two slices of wheat bread, one cup of juice drink
11 p.m.	Cheese steak sandwich with onion			

Each day includes all intakes from 12 midnight to 12 midnight, except for water. All eating events at home unless noted. *Theme 1: chaos*—eating rhythm differs in timing, spacing, and content across days, days begin and end at different times (# 222). *Theme 2: kitchen never closes*—eating events are irregularly spaced across day, both close together and with long fasts (#39). *Theme 3: supply-driven eating*—fewer foods, used in large portions and appearing in consecutive meals (# 217, Sloppy Joe meat). *Theme 4: mixed (up) plate*—meals are not typically composed; varied foods and amounts are oddly combined (#217, day 3, 2 pm). *Theme 5: traditional breakfasts*—even the most chaotic days often have large traditional breakfasts (#39 days 1 and 2, #222, day 2). *Theme 6: alcohol*—substantial intake, outside of meals, across day. “Drinking days” can include meals (#222, day 1, #217, day 2). *Theme 7: other beverages*: sweetened beverages and sodas, in large portions, throughout the day (# 217, day 2, # 194). *Theme 8: other patterns*: large amounts of candy, processed meat, salted foods, low intake of dairy (#39 candy, #222 meat, #194 salt)

^aRecall day is Sunday

RESULTS

Most intervention participants did not report healthful diets at baseline (Figures 1 and 2). Fifteen percent met no dietary goals, and 46% met only one. Alcohol avoidance was most common; 65% reported no alcohol in any recall. Moderate calorie consumption was the second most common, although reported by only 26%. Seventeen percent averaged <30% of calories from fat, and only 17% averaged an HEI of ≥ 65 . Averaging 5+ servings of fruits and vegetables was the least common behavior; only 15% met this goal.

Summed scores show that only 6% achieved a score of 3, 5% a 4, and only one respondent met all five goals. We tested the underlying structure of responses and found that these respondents' response patterns formed a Guttman scale, with a coefficient of reproducibility of 0.90. Thus, in 90% of responses, scores also exactly reflect response patterns for specific items. Women scoring 2 are likely to report no alcohol and 1,600–2,000 cal/day but are unlikely to have moderate fat intake, HEI of 65+, and 5+ fruit and vegetable servings. This also demonstrates that the most uncommon goal (consuming five or more servings of fruits and vegetables daily) was seldom achieved without all other components.

FIGURE 1. Cancer-related dietary risk reduction frequency of each dietary behavior among respondents.

FIGURE 2. Guttman scale scores. Sum of five possible cancer-related dietary risk reduction behaviors.

Bivariate results in Table 1 show that poorer cancer prevention was associated with younger age, being born in DC, and reporting depressive symptoms and was strongly related to reporting three or more recent stressful life events. There is a positive relationship between larger body size and scale scores, with morbidly obese (BMI≥40) women having higher scores than underweight, normal, or overweight women. However, for all other health indicators, higher scores are associated with more healthful behaviors (not smoking, exercising once a week, and anticipating better future health). Women receiving food stamps report lower scores. Women who can travel to stores either in their own cars or on public transportation report better diets, as do those planning meals before shopping. Finally, those who believe that specific foods can reduce cancer risk are more likely to score higher than those who do not or are not sure.

The multivariate model shows that, adjusting for other covariates, higher scores are significantly related to older age and menu planning prior to shopping and that the odds of higher scores is significantly lower among women reporting depressive symptoms, stressful life events, and current tobacco use. Modest associations ($p<0.10$) for higher prevention scores were associated with anticipation of better future health and traveling to food shopping with one’s own car or public transportation, and modest negative associations were seen for women who received food from nonpurchased sources, such as WIC or food pantries. Place of birth, BMI, food stamp receipt, and awareness of dietary-related cancer risk reduction were not statistically significant independent predictors of dietary score, when modeled with other covariates, and thus are not included in the final most parsimonious model.

Table 2 provides insight into individual dietary elements and behaviors leading to differences in scale scores. Number of daily eating events is just over four, with no significant variation by score. However, lower-scoring women have first meals later in the day, consume more calories at last daily events, describe more snack events,

and eat more fat and less fiber per event. For all women, most eating occurs at home; however, lower-scoring women have more events at friends' houses.

Specific foods differ as well. Vegetable intake differences are driven by dark green and yellow vegetables, not tomatoes, other vegetables, or vegetable juices. Differences in fruit categories include noncitrus fruits and citrus juices and, less strongly, citrus fruits and noncitrus juices. Higher-scoring women also consumed more milk, diet soda, and sweetened teas. More whole-grain breads are consumed by higher-scoring women, while more cold cuts, sausages, and cured pork meats are reported by lower-scoring women.

Nutrient analysis shows that low scorers consume more calories but, more significantly, less fiber and more fat and protein, with more of that protein ($>3/4$) from animal sources. They consume more cholesterol and sodium but less iron and vitamins A and C. (Average vitamin D and E and calcium intakes were extremely low, without group-specific differences—results not shown).

Qualitative Results

Women Scoring 0 The qualitative analysis of recalls from women failing to achieve any dietary goals yielded eight specific themes (Table 3).

1. Chaos—the most striking pattern is one of irregularity, evidenced by a set of three daily recalls which are dissimilar from one another in many ways. Every day is different: eating begins and stops at different times across the 3 days, with events differing in total number, timing, and composition.
2. The kitchen never closes—within any given day, eating events are neither spaced in time nor occur at regular “mealtimes.” A relatively high-calorie event may be followed closely by another large meal. Other days contain only hourly beverage consumption, until several snack events occur late at night.
3. Supply-driven eating—food events contain large portions of very few foods, and single foods may appear in large portions consecutively, at multiple meals and days. This lack of variety, within and across days, presents a striking image of food insecurity.
4. The mixed (up) plate—nontypical meal composition—meals are not recognizable by typical time or composition. Foods are combined in eating events in unusual ways, and food events do not appear to be “composed”. Portions vary from very small to very large amounts; thus, nutritional content varies widely, depending on one or two food choices. A day might contain 10+ vegetable servings from one meal or no vegetables at all.
5. Traditional breakfasts—exception to chaotic patterns are large traditional breakfasts. When these occur, they often contain multiple foods, e.g., several types of breakfast meats, eggs, and pancakes.
6. The role of alcohol—alcohol consumption is typically not daily but in large quantities. It is consumed at different times of day, although most typically after midday, at home, and outside of meals. Daily totals result from both single large amounts but also small amounts across the day. However, days with alcohol often include structured meal events with good quality and variety of foods.
7. Other beverages—beverage portions are large and occur throughout the day. Typical beverages are sweetened sodas or punches.

8. Other noteworthy food patterns—there is a noticeable amount of candy eaten, especially “children’s candy.” Meat, especially processed meat, is consumed as often as three or four times daily, in large amounts, as are salted foods. Notably missing is dairy.

Women Scoring 4 or 5 There are many similarities between these women and those scoring zero. Their diets are low in dairy and fruit and high in sodium, fat, and meat. There is a large amount of candy and consistent use of low-cost high-fat foods, such as hotdogs, chicken wings, and fried potatoes.

Differences, however, are also notable. Meals appear more purposefully composed of elements customarily brought together, thus appearing to attractively “go together.” A meal of breakfast foods, such as oatmeal, is often the first eating event. There is a greater variety of foods, both across each day and at each meal, including lunches and dinners where two or more vegetables accompany meat. More effort appears to be put into planning and preparing meals at customary times, although there is frequent use of canned or frozen combination foods.

Portion sizes are less extreme, perhaps because each meal contains more items. More items yield more opportunities for variety, including fruits and vegetables, rather than large amounts of one or two items. There is also wider use of fruits and vegetables in mixed food dishes, including adding raisins or bananas to oatmeal and choosing Chinese carryout dishes containing vegetables.

DISCUSSION

Among women at risk for poor diet due to their low resources and entering a nutrition education program, we found that five cancer-related dietary behaviors (fruit and vegetable intake, alcohol avoidance, reduced calorie and fat intake, and the generally agreed-upon elements of a varied and healthful diet, as measured by USDA’s Healthy Eating Index) had a scalar relationship. Furthermore, one of the most widely promulgated cancer-related dietary messages, 5+ daily servings of fruits and vegetables, was the most difficult to achieve. This suggests that nutritional behavior change must be approached as an interrelated stepwise process, rather than a single-change message.

These five indicators have both face and content validity and represent well-known and commonly proscribed dietary recommendations, used in many interventions and campaigns. For example, the HEI has recently been selected by the Institute of Medicine as a dietary indicator to include when monitoring population health at the State level.³⁰

Because the indicators are calculated from a variety of dietary behaviors, they may be relatively robust against reporting errors. Although fruits, vegetables, and fat contribute modestly towards overall HEI scores, we emphasize them as stand-alone elements due to their prominence in cancer-related dietary messages. Arguably, with more extensive scale development, other combinations of dietary items, including newer HEI guidelines, could be additionally informative. Furthermore, Guttman scales are data dependent. Given our initial findings, scalar relationships between these elements should be tested in other populations, with sufficient sample size for multivariate modeling of psychosocial predictors.

The influence of alcohol in these diets is complex. Our data reflect well-established evidence that alcohol use is less frequent but potentially more harmful

among African-American women.³¹ Recall examples in Table 3 reflect popularity of malted liquors and stronger spirits,^{32,33} as well as potential for excess drinking (>2 drinks per day for women). However, drinkers often had more substantial meals on days when they drank, suggesting that social or financial events which facilitate excessive alcohol use may also promote food availability. This may suggest that interventions around food budgeting should include discussions of alcohol-related spending.

We chose recalls in Table 3 as examples of typical intake (median=30 g/day) rather than the maximum drinking (322 g/day). There is no evidence that social desirability influenced reported intake, but accurate recall the day after heavy drinking is unlikely.

Of note, 23 respondents (14%) were self-described as occasional (less than once a month) drinkers on questionnaire but consumed no alcohol on the observed recall days. Thus, it is possible that we classified some infrequent drinkers as nondrinkers, and thus their scale scores were one point higher than if we had captured one of these rare days with alcohol. This issue is not limited to alcohol intake but extends to any nontypical intake patterns because the 24-h recall methodology is less sensitive than food frequency methods for foods or beverages consumed infrequently. Other limitations of self-reported dietary measurement are well known, including the potential for underreporting and socially desirable reporting by certain groups, including the overweight. This suggests, for example, that our bivariate finding of higher scores among the very obese must be considered with caution.¹⁹

Women reporting worse diets were younger. In cross-sectional data, we cannot determine if they will age into more healthful diets or if the health behaviors demonstrated by older women stem in part from lives begun outside of DC or other generational differences. At a minimum, this difference suggests age-targeted or younger-older partner-based programs may be needed. Similarly, the significant relationship between food assistance and poor diet, triangulated qualitatively by recalls dominated by single foods, does not imply causality but does starkly illustrate both the needs of households depending on, as well as the limits of, such assistance.

The benefits of a mixed-method approach to understanding diet in this population were substantial. The quantitative analysis allowed us to decompose eating events to understand, and perhaps prioritize, specific elements among the myriad number of nutritional problems stemming from poor diet. However, the qualitative analysis allowed us to recompose those elements into a food culture within the lives of these women and to feel the full impact of their quantitative scores. For example, from a household receiving nonpurchased food, we see a woman consuming, across sequential days, little more than Kool-Aid and Sloppy Joes, first with and later without rolls. Beyond insufficient variety, this also contextualizes precarious fruit and vegetable intake—here, achieved only through tomato sauce.

These analyses demonstrate that all women entering our intervention would benefit from its content, as even the relatively healthy diets in this population need improvement. For example, higher-scoring women consume more milk but also more soda and sweetened tea; therefore, they could benefit from beverage-focused nutrition education. Similarly, their average sodium, fat, fiber, and cholesterol intakes could be improved.

This supports decisions, made with community partners, for inclusive enrollment, group-based processes, and broadly focused content, with a goal to develop methods and materials easily adopted by other low-resource groups.

However, the drawbacks of forgoing individually tailored behavioral strategies is apparent;³⁴ some women were far readier than others to take advantage of food-related skill building, such as weekly menu planning and shopping within a budget. Overall, despite shared poverty, the social and psychological differences between healthy and unhealthy eaters in these communities suggest low scorers would need substantial support to change their diets. It could be argued that, among younger women describing other immediate threats to their well-being (including depression, tobacco and alcohol use, and multiple stressful life events), addressing dietary behaviors for long-term risk reduction is less urgent. However, as heart disease and cancer continue as the first and second leading causes of death for African-American women,³⁵ we suggest that nutrition must be a critical component of any health disparities agenda.

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