

# The Healthy Eating Index and Youth Healthy Eating Index Are Unique, Nonredundant Measures of Diet Quality among Low-Income, African American Adolescents<sup>1,2</sup>

Kristen M. Hurley,<sup>3\*</sup> Sarah E. Oberlander,<sup>3</sup> Brian C. Merry,<sup>3</sup> Margaret M. Wroblewski,<sup>3</sup> Ann C. Klassen,<sup>4</sup> and Maureen M. Black<sup>3</sup>

<sup>3</sup>Department of Pediatrics, University of Maryland School of Medicine, Baltimore MD 21201 and <sup>4</sup>Department of Health, Behavior, and Society, The Johns Hopkins Bloomberg School of Public Health, Baltimore, MD 21205

## Abstract

Chronic disease is related to poor diet quality. The Healthy Eating Index (HEI) was developed to assess diet quality. The Youth HEI (YHEI) is an adaptation of the HEI for use with children and adolescents. The objectives were to compare HEI and YHEI scores among adolescents at risk for chronic disease and to compare associations between the scores and health indicators. This cross-sectional study included 2 low-income, urban African American adolescent samples (Challenge,  $n = 196$ ; Three Generation,  $n = 121$ ). HEI and YHEI scores were calculated from a FFQ and compared with BMI, body composition, and micronutrient, energy, and dietary intakes. YHEI scores were lower than HEI scores across both adolescent samples (Challenge,  $48.94 \pm 9.31$  vs.  $62.83 \pm 11.75$ ; Three Generation,  $47.08 \pm 9.65$  vs.  $59.93 \pm 11.27$ ;  $P < 0.001$ ). Females ( $64.47 \pm 11.70$ ) had higher HEI scores than males ( $61.15 \pm 11.61$ ) ( $P < 0.05$ ), but there was no gender difference in YHEI scores. HEI and YHEI scores were associated with higher micronutrient and total energy intakes ( $r = 0.19$ – $0.76$ ;  $P < 0.05$ ). Higher percent body/abdominal fat was associated with lower HEI scores ( $r = -0.17$  to  $-0.19$ ;  $P < 0.05$ ) but not with YHEI scores. BMI was not associated with either HEI or YHEI scores. In conclusion, many adolescents were consuming diets that placed them at risk for developing chronic disease. Although both the HEI and YHEI are useful in assessing diet quality, the HEI is inversely associated with body composition, a predictor of chronic disease, and accounts for gender differences in the Dietary Guidelines, whereas the YHEI discounts nutrient-poor, energy-dense foods. J. Nutr. 139: 359–364, 2009.

## Introduction

Four of the leading causes of death in the United States, cancer, type 2 diabetes, cardiovascular disease (CVD),<sup>5</sup> and hypertension, are related to poor diet quality (e.g. diet high in fats and

added sugars and low in micronutrients and fiber), with risk factors occurring as early as childhood (1–5).

Chronic diseases occur disproportionately among minority populations. The cancer death rate in 2003 was 18% higher in African American women and 35% higher in African American men than in white women and men (6). National nutrition data found that African Americans had significantly lower vegetable consumption compared with whites (7), which may contribute to their higher rates of cancer and other chronic diseases. For example, African Americans are almost twice as likely as whites to have diabetes (8) and CVD remains America's leading cause of death for both African Americans and whites (9). Among African Americans, 45% of men and 49% of women have CVD compared with 37% and 35% of white men and women (9). Racial health disparities are not limited to adults. Ethnic differences for early onset CVD and diabetes risk factors such as excessive adipose tissue, elevated systolic blood pressure, and hyperglycemia are evident in African American children as young as 6–9 y of age (10), indicating the importance of creating

<sup>1</sup> Supported by grants R40MC00241, MCJ-240301, and R40MC04297 from the Maternal and Child Health Research Program, US Department of Health and Human Services; grant APRPA006000 from the Office of Population Affairs, US Department of Health and Human Services, the University of Maryland General Clinical Research Center grant M01 RR16500; General Clinical Research Centers Program, National Center for Research Resources (NCRR), NIH; and grants from the Collaborative Cigarette Restitution Fund Program and the Maryland Cigarette Restitution Fund.

<sup>2</sup> Author disclosures: K. M. Hurley, S. E. Oberlander, B. C. Merry, M. M. Wroblewski, A. C. Klassen, and M. M. Black, no conflicts of interest.

<sup>5</sup> Abbreviations used: CVD, cardiovascular disease; DEXA, dual energy x-ray absorptiometry; HEI, Healthy Eating Index; YAQ, Youth/Adolescent FFQ; YHEI, Youth Healthy Eating Index.

\* To whom correspondence should be addressed. E-mail: khurley@peds.umaryland.edu.

a tool to screen diet quality and chronic disease risk prior to adulthood, especially in minority children.

The Dietary Guidelines for Americans (11) are recommendations for establishing dietary patterns that promote health and reduce the risk of chronic disease in children and adults. Strategies to measure dietary patterns, overall diet quality, and chronic disease risks summarize comprehensive food and nutrient data into a single number or overall diet quality score (12). For example, the Healthy Eating Index (HEI) measures how closely individuals over the age of 2 y adhere to the Dietary Guidelines for Americans (13). HEI scores range from 0 to 100, with higher scores indicating better diet quality. HEI scores > 80 indicate a "good" diet, scores ranging from 51 to 80 reflect a diet that "needs improvement," and HEI scores < 51 imply a "poor" diet (7). However, when used to predict chronic disease in longitudinal studies, the HEI has met with mixed success. Higher HEI scores in men and women were associated with a lower risk of CVD, but the scores were weak indicators of overall chronic disease risk (14,15).

The Youth HEI (YHEI) was developed to rate diet quality in children and adolescents by scoring food consumption and addressing dietary behaviors pivotal to healthy childhood and adolescent growth and development, such as eating breakfast, attending family dinners, and avoiding snack foods and soft drinks (16). Higher YHEI scores indicate the consumption of nutrient-dense, healthy foods and nutrition-promoting eating behaviors. In essence, the HEI is a measure of the nutrient quality of the diet and the YHEI is a measure of the quality of dietary behaviors and consumption of nutrient-dense foods.

To date, the YHEI has been applied to a sample of primarily white children and adolescents (ages 9–14 y) whose parents were enrolled in the Nurses Health Study II cohort, using self-reported anthropometric data (16). To our knowledge, the YHEI has not been used or validated on the population most vulnerable to chronic diseases: low-income, minority youth. The purpose of this study is 2-fold: 1) to compare HEI and YHEI scores across 2 samples of low-income African American urban adolescents; and 2) to compare associations between HEI and YHEI scores and health indicators to assess the relative strength of each measure in predicting the dietary risks for chronic disease. Because the HEI scores are partially driven by total fat consumption and YHEI scores reflect healthy dietary patterns (i.e. high consumption of whole grains and low consumption of snacks, desserts, and sweetened beverages), we expected that the 2 measures serve different assessment needs in a youth population. We hypothesized that: 1) higher HEI scores are associated with lower percent body fat and abdominal fat; and 2) higher YHEI scores are associated with higher micronutrient intakes, lower BMI measurements, and lower total energy intakes.

## Materials and Methods

### Participants

The sample included low-income, urban African American adolescents from 2 longitudinal, randomized, controlled trials designed to promote either healthy dietary and activity patterns among middle school students (Challenge Study) (MM Black, E Hager, F Shebl, unpublished data) or positive parenting practices among young mothers (Three Generation Project) (17). In the current analysis, we assessed baseline (Challenge Study,  $n = 196$ ) and 13-mo (Three Generation Project,  $n = 121$ ) data. The procedures were approved by the Institutional Review Boards at the University of Maryland School of Medicine and all participating sites. All participants (or their parents) signed assent or informed consent forms and were compensated for evaluation visits. Evaluators were not aware of the participants' intervention status.

### Challenge

Adolescents were recruited from a primary care site or from 3 urban public middle schools. Eligibility criteria included specific age (11–16 y) and willingness to participate. Weight status was not mentioned and was not a condition of recruitment. Baseline data were collected prior to randomization, from April 2001 through May 2004, and included demographics, anthropometrics, body composition, and an FFQ.

At baseline, the mean age of the adolescents was 13.2 y (range 11–16). The adolescents were evenly divided by gender (49% females), 12% were overweight, and 27% were obese (Table 1).

### Three Generation Project

Adolescent mothers were recruited shortly after delivery from 3 urban hospitals between June 1997 and September 1999. They were approached shortly after delivery and given a brochure explaining the study. Eligible mothers were <18 y of age, primiparous, African American, low-income (defined as family income < 185% of poverty level, or eligible for the Special Supplemental Nutrition Program for Women, Infants, and Children), and had no chronic or mental illnesses that would interfere with parenting or adolescent development. Infants of eligible mothers had to be full-term ( $\geq 37$  wk) with a birth weight > 2500 g, with no congenital problems or chronic illnesses.

Data at 13 mo postpartum were collected from February 1998 through May 2001 and included demographics, anthropometrics, and an FFQ (18). The mean age of the adolescents was 17.5 y (range 14–19), 22% were overweight, and 35% were obese (Table 1).

### Measures

**Anthropometry.** Trained staff members collected all anthropometric data for adolescents (19). Anthropometry measurement procedures and protocols were the same for the Challenge and Three Generation samples. Height was measured to the nearest 0.5 cm with a wall-mounted stadiometer and weight was measured to the nearest 100 g with a digital scale (Tanita). BMI was calculated as  $\text{kg}/\text{m}^2$ . BMI values were converted to Z-scores and percentiles based on the 2000 CDC age- and gender-specific tables using algorithms (20). Adolescents were divided into the following categories based on their age-adjusted, gender-specific BMI percentiles: normal weight (<85th percentile), overweight ( $\geq 85$ th percentile and <95th percentile), and obese ( $\geq 95$ th percentile).

**Body composition (measured only in Challenge participants).** Body composition was measured by dual energy x-ray absorptiometry (DEXA). The DEXA scan was conducted at the University of Maryland

**TABLE 1** Health characteristics among Challenge and Three Generation adolescents<sup>1</sup>

Health characteristics	Guidelines <sup>1</sup>	Challenge	Three Generation
<i>n</i>		196	121
BMI $\geq 85$ th percentile, <sup>2</sup> %	15	39	57
BMI $\geq 95$ th percentile, <sup>2</sup> %	5	27	35
Total energy, kJ/d	2200–3000	2613.30 $\pm$ 1136.30	2394.10 $\pm$ 1018.50
Calcium, <sup>3</sup> mg/d	1300	1126.11 $\pm$ 579.36	907.48 $\pm$ 500.66
Iron, <sup>3</sup> mg/d	11–15	16.43 $\pm$ 7.94	14.42 $\pm$ 7.37
Dietary fiber, <sup>3</sup> g/d	26–38	18.60 $\pm$ 9.67	16.62 $\pm$ 8.96
Folate, <sup>3</sup> $\mu\text{g}$	400	446.21 $\pm$ 217.21	290.16 $\pm$ 160.48
Total body fat, <sup>4</sup> kg	11.80	16.71 $\pm$ 11.13	–
Abdominal fat, <sup>4</sup> kg	4.70	6.61 $\pm$ 5.15	–

<sup>1</sup> Values are means  $\pm$  SD or percent.

<sup>2</sup> BMI guidelines were based on 2000 CDC age- and gender-specific tables (31).

<sup>3</sup> Recommendations for macro- and micronutrient intakes are from reference (32).

<sup>4</sup> Guidelines for percent body fat and abdominal fat were obtained from a similar sample of healthy, urban, African American children and adolescents and used as comparisons in the absence of established guidelines (28).

School of Medicine General Clinical Research Center following a standardized protocol using a Hologic QDR 4500 W scanner. We calculated percentages of body fat and abdominal fat using software and protocol provided by the scanner manufacturer. Abdominal fat was defined as the percentage of fat in an abdominal region-of-interest rectangle (horizontal sides: drawn at the upper edge of the body of the 2nd lumbar vertebra and the lower edge of the body of the 4th lumbar vertebra; vertical sides: connected the lateral inferior borders of the rib cage and the iliac crest). The usefulness of abdominal region-of-interest analysis of DEXA in predicting intra-abdominal fat has been independently validated (21,22).

### Youth/Adolescent FFQ

Dietary patterns were measured with the Youth/Adolescent FFQ (YAQ), an instrument that has been developed and validated for use with adolescents (23–25). The YAQ was self-administered and adolescents reported foods consumed over the past 12 mo. It also includes several eating behavior questions (e.g. frequency of eating breakfast). Response categories differed by food. For example, response categories for snacks and desserts ranged from “never or less than once per month” to “5 or more times per week.” Juice response categories ranged from “never or <1 glass per month” to “2 or more glasses per day.” Food quantities on the YAQ reflected standard food portions available and familiar to youth and adolescents. For example, most of the servings of snacks refer to a serving size of “1 small bag” and respondents indicated the number of bags consumed in 1 mo or wk. The YAQ contains 131 total items and yields estimated scores on energy and other macronutrients, micronutrients, and mean daily servings of foods consumed. Thirty-four participants with out-of-range energy values [ $<500$  or  $>5000$  kcal ( $<2093$  or  $>20934$  kJ)] were excluded from the analyses.

**HEI.** The HEI was developed by the USDA Center for Nutrition Policy and Promotion (7). The original HEI, released in 1995, consists of 10 components, each with scores ranging from 0 to 10. Higher component scores represent higher diet quality. The first 5 components measure adherence to the recommended daily intake for the 5 major food groups: grains, vegetables, fruits, milk, and meat. The remaining 5 components measure total fat consumption, saturated fat intake as a percentage of total food energy intake, total cholesterol intake, total sodium intake, and dietary variety. A perfect score is 100. The HEI accounts for age and gender when creating the index scores based on serving sizes. A 2005 revision (HEI-2005) reflects the 2005 Dietary Guidelines represented in MyPyramid (26). We used the original HEI in this study to reflect the dietary guidelines and Food Guide Pyramid in use at the time of data collection.

**YHEI.** The YHEI is a modified version of the HEI designed to capture dietary behaviors common to children and adolescents (16). Like the HEI, the YHEI total scores range from 0 to 100, with higher scores indicating better diet quality. The YHEI consists of 13 components. The first 7 components are scored from 0 to 10. The remaining 6 components are scored from 0 to 5. The first 3 components are whole grains, vegetables, and fruits. Component 4 measures dairy consumption, but gives half a point for each serving of high-fat dairy foods such as ice cream and whole milk. Component 5 measures protein consumption as a meat ratio by dividing healthy, lean proteins (e.g. poultry, fish, and tofu) by less healthy, higher fat meats (e.g. beef, pork, and lamb). Component 6 measures consumption of snack foods high in salt or sugar. Component 7 assesses sweetened beverage intake such as regular soda, fruit punch, and sweetened iced tea. The final 6 components measure multivitamins, margarine and butter, fried foods outside of the home, visible fat on meat (including skin), and breakfast and dinner patterns. The YHEI does not account for gender or age differences in serving size recommendations.

### Statistical analysis

The YAQ from the Challenge and Three Generation samples served as the basis for calculating HEI and YHEI component and total scores. HEI scores reflect serving sizes defined by the USDA Food Guide Pyramid and vary by age and gender. The YHEI scores reflect the 5-A-Day serving size recommendations for the National Cancer Institute (23). For both the HEI and YHEI, multicomponent foods are disaggregated when scored

(e.g. pizza contributes toward the nonwholewheat grain, dairy, and vegetable components of the HEI).

In the Challenge sample, we combined the 2 male age groups, 11–14 ( $n = 99$ ) and 15–18 ( $n = 6$ ) and used  $t$  tests to examine gender differences in total and component mean HEI and YHEI scores. We used Pearson correlations to examine the relationships between the HEI and YHEI total scores with other health indicators, including micronutrient intakes, energy intake, sweetened beverage intake, snack and dessert intake, BMI, and percent body fat and abdominal fat measured by DEXA (only in the Challenge sample), followed by Fisher R-Z transformations to compare the magnitude difference between HEI and YHEI correlations. We set significance at 0.05 and values in the text are means  $\pm$  SD.

In the Three Generation sample, HEI and YHEI scores did not differ significantly by intervention group status. Nine participants in the Three Generation sample were either pregnant ( $n = 6$ ) or lactating ( $n = 3$ ). They were included in the analysis, because BMI scores or scores on the HEI and YHEI did not differ by pregnancy/lactation status.

## Results

The distribution of BMI scores was higher compared with national standards in both the Challenge and Three Generation samples, with adolescents in the latter sample having higher BMI (Table 1). Participants' fiber and calcium intakes were below recommended nutritional guidelines. Although energy intakes were within recommended ranges, 53.6% of the Challenge participants and 52.9% of the Three Generation participants had energy intakes exceeding the estimated energy requirements for their age and gender. Body fat and abdominal fat measurements among Challenge participants were similar to values obtained from a comparative sample of 274 healthy African American children and adolescents in New York City (27).

**HEI/YHEI scores by sample.** The HEI score in the Challenge sample ( $62.83 \pm 11.75$ ) was higher than the score calculated in the Three Generation sample ( $59.93 \pm 11.27$ ) ( $P < 0.05$ ; Table 2). The HEI dairy component score was higher in the Challenge sample ( $7.11 \pm 2.79$  vs.  $6.16 \pm 3.01$ ;  $P < 0.01$ ). All other HEI component scores were consistent between samples.

The YHEI scores were consistent across samples (Table 3). The 2 samples differed in component scores for vegetables (Challenge,  $5.90 \pm 2.87$ ; Three Generation,  $5.16 \pm 2.69$ ;  $P < 0.05$ ) and dairy (Challenge,  $6.65 \pm 2.81$ ; Three Generation,  $5.50 \pm 2.98$ ;  $P < 0.01$ ) with higher scores among the adolescents in the Challenge sample. All other component scores were consistent between samples. Total YHEI scores were less than total HEI scores in both the Challenge ( $48.94 \pm 9.31$  vs.  $62.83 \pm 11.75$ ;  $P < 0.001$ ) and the Three Generation ( $47.08 \pm 9.65$  vs.  $59.93 \pm 11.27$ ;  $P < 0.001$ ) samples.

**HEI/YHEI scores by gender.** Among Challenge participants, the overall HEI score was higher in females ( $64.47 \pm 11.70$ ) than in males ( $61.15 \pm 11.61$ ) ( $P < 0.05$ ). Similarly, HEI component scores for fruits ( $6.11 \pm 3.08$  vs.  $5.05 \pm 3.02$ ;  $P < 0.05$ ) and vegetables ( $5.17 \pm 2.75$  vs.  $4.13 \pm 2.47$ ;  $P < 0.01$ ) were higher in females than in males. The overall YHEI score did not differ by gender among Challenge participants; however, whole grain component scores were higher among females ( $1.95 \pm 2.24$ ) than males ( $1.29 \pm 1.50$ ) ( $P < 0.05$ ; Table 2). Nonsignificant gender differences are not shown. When comparing the mean and component HEI scores for Challenge females and males, the 2 male age groups, 11–14 y ( $n = 99$ ) and 15–18 y ( $n = 6$ ), were combined.

**Relationships between HEI/YHEI scores and health indicators.** HEI and YHEI scores were compared with intakes of

**TABLE 2** HEI scoring criteria among Challenge and Three Generation adolescents

HEI component	Gender	HEI scoring criteria		HEI scores, mean (range)	
		Requirement for minimum score of 0	Requirements for maximum score of 10	Challenge (n = 196)	Three Generation (n = 121)
			<i>Servings/d</i>		<i>Higher HEI scores are optimal</i>
Grains	Females/males	0	8.0/9.0–9.9	5.22/4.57 (1–10)	4.51 (1–10)
Vegetables <sup>1</sup>	Females/males	0	4.0/4.5–5.0	5.17/4.13 (0–10)	4.17 (1–10)
Fruits <sup>1</sup>	Females/males	0	3.0/3.5–4.0	6.11/5.05 (0–10)	5.57 (0–10)
Dairy <sup>2</sup>	Females/males	0	3.0/3.0	6.97/7.25 (0–10)	6.16 (1–10)
Meat	Females/males	0	2.4/2.6–2.8	7.54/6.94 (0–10)	7.26 (1–10)
			<i>% energy</i>		
Total fat	Females/males	≥45	≤30	7.58/7.53 (0–10)	7.08 (0–10)
Saturated fat	Females/males	≥15	<10	6.94/6.35 (0–10)	6.12 (0–10)
			<i>mg/d</i>		
Cholesterol	Females/males	≥450	≤300	6.96/7.22 (0–10)	7.02 (0–10)
Sodium	Females/males	≥4800	≤2400	6.33/7.07 (0–10)	7.31 (0–10)
Food variety	Females/males	≤3	≥8	5.80/5.11 (0–10)	4.74 (0–10)
HEI score (0–100) <sup>1</sup>				64.47/61.15 (28–86)	59.93 (34–85)

<sup>1</sup> Among Challenge participants, mean component scores for vegetables and fruits and overall mean HEI scores were higher in females than males ( $P < 0.05$ ).

<sup>2</sup> Mean HEI dairy component score was significantly higher in the Challenge sample than the Three Generation sample ( $P < 0.01$ ).

micronutrients, energy, sweetened beverages, and snacks/desserts, as well as BMI, percent body fat, and abdominal fat (Table 4). For both the HEI and YHEI, there were significant positive correlations between total index scores and micronutrients and total energy intakes (Table 4). Across samples, the magnitude of the correlation was significantly higher for the HEI compared with the YHEI for fiber, folate, snacks and desserts, sweetened beverages, and energy intake. In the Challenge sample, the magnitude of the correlation was significantly higher for the HEI vs. YHEI for iron. Higher sweetened beverages and snack/dessert intake were significantly related to a higher overall HEI

score. Among Challenge participants, higher percent body fat and abdominal fat were significantly associated with a lower overall HEI score. BMI and total HEI or YHEI scores were not significantly associated. However, the directions of the associations were consistent with our hypothesis (Table 4).

## Discussion

The current study reveals 5 major findings. First, across both samples of low-income, urban African American adolescents, HEI and YHEI scores reflect suboptimal diet quality, indicated

**TABLE 3** YHEI scoring criteria among Challenge and Three Generation adolescents

YHEI component	YHEI scoring criteria		YHEI scores, mean (range)	
	Requirement for minimum score of 0	Requirements for maximum score of 10	Challenge, n = 196	Three Generation, n = 121
		<i>Servings/d<sup>1</sup></i>		<i>Higher YHEI scores are optimal</i>
Whole grains	0	≥2	1.62 (0–10)	1.31 (0–10)
Vegetables	0	≥3	5.90 (0–10)	5.16 (1–10)
Fruits	0	≥3	5.80 (0–10)	5.57 (0–10)
Dairy	0	≥3	6.65 (1–10)	5.50 (1–10)
Meat ratio <sup>2</sup>	0	≥2	6.28 (0–10)	6.77 (1–10)
Snack foods <sup>3</sup>	≥3	0	2.24 (0–10)	2.58 (0–9)
Sweetened beverages	≥3	0	4.37 (0–10)	4.86 (1–10)
		Requirements for maximum score of 5		
Multivitamin use	Never	Daily	0.29 (0–3)	0.16 (0–3)
Margarine and butter	≥2 pats/d	Never	3.32 (0–5)	3.15 (0–5)
Fried food outside home	Daily	Never	3.36 (0–5)	3.14 (0–5)
Visible animal fat <sup>4</sup>	All	None	2.54 (0–5)	2.44 (0–5)
Eat breakfast (at all)	Never	Ever	4.74 (0–5)	4.54 (0–5)
Dinner at home	Never	Daily	1.98 (0–5)	1.89 (0–5)
YHEI overall			48.94 (25–78)	47.08 (22–72)

<sup>1</sup> Challenge and Three Generation used a FFQ to assess usual dietary intake. Serving sizes are based on definitions in the FFQ.

<sup>2</sup> Total number of servings per day of chicken, fish, eggs, nuts, seeds, soy/tofu, and beans divided by the total number of servings/day of beef, pork, lamb, and liver.

<sup>3</sup> Snack foods included salty snacks (e.g. potato chips, corn chips, nachos, popcorn, pretzels, and crackers) and snacks with added sugar (e.g. cake, snack cake, toaster pastry, sweet roll/danish/pastry, doughnut, brownie, cookies, pie, chocolate, candy bar with chocolate, candy without chocolate, fruit rollup, popsicle, and flavored gelatin).

<sup>4</sup> Visible animal fat includes the visible fat on meat and the skin on chicken and turkey.

**TABLE 4** Correlations between the HEI, YHEI, and diet/health indicators

	Challenge, <i>n</i> = 196		Fisher's R-Z ( $\lambda$ )	Three Generation, <i>n</i> = 121		Fisher's R-Z ( $\lambda$ )
	HEI	YHEI		HEI	YHEI	
Iron, mg/d	0.52**	0.30**	2.57**	0.63**	0.50**	1.44
Fiber, g/d	0.67**	0.46**	3.12**	0.76**	0.56**	2.85**
Folate, $\mu$ g	0.59**	0.38**	2.65**	0.74**	0.58**	2.22*
Calcium, mg/d	0.39**	0.34**	0.53	0.48**	0.45**	0.30
Snacks/desserts, servings/d	0.46**	0.06	4.23**	0.30**	-0.10	3.17**
Sweetened beverages, servings/d	0.14*	-0.39**	5.41**	0.22*	-0.24**	3.59**
Energy, kJ	0.53**	0.19**	3.94**	0.62**	0.31**	3.08**
BMI $\geq$ 85th %	-0.11	-0.11	-0.03	-0.07	-0.05	-0.12
BMI $\geq$ 95th %	-0.09	-0.05	-0.45	0.05	-0.02	0.54
Body fat, %	-0.17*	-0.09	-0.71	-	-	-
Abdominal fat, %	-0.19*	-0.09	-0.87	-	-	-

\* $P < 0.05$ , \*\* $P < 0.01$ .

by micronutrient deficiencies and HEI/YHEI scores within or below the “need to improve” diet quality categories. These findings are consistent with data from other samples of low-income, urban adolescents (27,28), illustrating that many of the dietary patterns associated with disparities in chronic illnesses are in place by adolescence.

Second, HEI scores differed by sample. Although the samples had similar patterns, the Challenge sample scored higher on the overall HEI than the Three Generation sample. Three Generation participants may have consumed more total fat, cholesterol, and sodium, thereby decreasing their overall HEI score. However, by consuming more foods in general, Three Generation participants increased their micronutrient intakes.

Third, females had higher HEI diet quality scores than males, particularly in fruit and vegetable consumption. The HEI accounts for differences in serving size recommendations by age and gender when creating the index scores, whereas the YHEI scoring system is consistent for males and females. Gender scores for overall diet quality and fruit and vegetable consumption did not differ when assessed by the YHEI, suggesting that females consumed as much as males, despite smaller serving size recommendations (11).

Fourth, adolescents in both samples scored lower on the YHEI than the HEI. There are major differences between the 2 coding systems. The YHEI gives points for whole-wheat breads/grains, whereas the HEI gives points for all grains. In addition, the YHEI subtracts points specifically for snacks, desserts, and sweetened beverage consumption, whereas the HEI credits foods regardless of their fat and added sugar content. This scoring difference explains how the HEI can be positively correlated with snacks, desserts, and sweetened beverages whereas the YHEI is negatively correlated with sweetened beverages. The HEI was more strongly associated with increased total energy consumption than the YHEI. By-products of this increased total consumption appear to include higher intakes of micronutrients, including calcium, iron, fiber, and folate. These findings suggest that in assessing and scoring diet quality, the HEI gives more weight to quantity and adequacy of intake, whereas the YHEI focuses more closely on quality and healthy dietary behaviors.

Fifth, the association between high HEI scores (but not YHEI scores) and low percent body and abdominal fat suggests that among adolescents, the HEI may be more successful than the YHEI at predicting chronic disease risk associated with high percent body fat and abdominal fat. One possible explanation

for this finding is that the HEI directly measures intake of total fat, saturated fat, and cholesterol, whereas the YHEI does not.

Methodological limitations should be considered when interpreting these findings. First, the data collection design may have biased estimates of consumption due to the possibility of recall error when using self-report dietary recall (29). However, dietary consumption in the present study was similar to adolescent consumption patterns in the USDA nationwide Continuing Survey of Food Intakes by Individuals 1994–1996 sample (7). Second, we had objective data on percent body and abdominal fat but not physiological predictors of chronic disease (e.g. cholesterol). Third, similar to the Feskanich et al. (16) study, we assessed diet quality using the YAQ. Although the HEI coding system was designed to assess diet quality via 24-h dietary recall scores, HEI scores calculated from the FFQ were consistent with those from diet recalls of adolescents in a nationwide sample (7), suggesting the utility of using a FFQ to score the HEI.

In summary, many adolescents in both samples had BMI values higher than recommended and were consuming diets that placed them at risk for developing chronic disease.

The positive associations between both the HEI and YHEI and micronutrient intakes suggest that both measures are valid data reduction strategies to assess diet quality during adolescence (12). The HEI is associated with physiological predictors of chronic disease (e.g. body fat and abdominal fat) and accounts for gender differences in the Dietary Guidelines but credits foods regardless of their fat and added sugar content (e.g. snacks and desserts). Conversely, the YHEI was not associated with physiological predictors of chronic disease and does not account for gender differences in the Dietary Guidelines, but it discounts nutrient-poor, energy-dense foods (e.g. sweetened beverages). The HEI-2005 incorporates saturated fat consumption, accounts for gender differences in the Dietary Guidelines, and credits nutrient-dense foods (e.g. whole grains). Future research is needed to compare the HEI-2005, the HEI, and the YHEI as predictors of chronic disease risk among pediatric populations.

## Literature Cited

1. National Center for Chronic Disease Prevention and Health Promotion. Healthy People 2010 and the National Initiative to Improve Adolescent Health [version current 2007 Jun 8; cited 2008 Jul 18]. Available from: <http://www.cdc.gov/HealthyYouth/AdolescentHealth/NationalInitiative/>.

2. Tercyak KP, Tyc VL. Opportunities and challenges in the prevention and control of cancer and other chronic diseases: children's diet and nutrition and weight and physical activity. *J Pediatr Psychol.* 2006;31:750–63.
3. Uauy R, Solomons N. Diet, nutrition, and the life-course approach to cancer prevention. *J Nutr.* 2005;135:S2934–45.
4. Hursting SD, Cantwell MM, Sansbury LB, Forman MR. Nutrition and cancer prevention: targets, strategies, and the importance of early life interventions. *Nestle Nutr Workshop Ser Pediatr Program.* 2006;57:153–202.
5. World Cancer Research Fund and the American Institute for Cancer Research. Food, nutrition, physical activity, and the prevention of cancer: a global perspective [cited 2008 Jul 18]. Available from: <http://www.dietandcancerreport.org/>.
6. American Cancer Society. Cancer facts and figures for African Americans 2007–2008. Atlanta: American Cancer Society; 2007.
7. Basiotis P, Carlson A, Gerrior S, Juan W, Lino M. The Healthy Eating Index: 1999–2000. Washington, DC: USDA, Center for Nutrition Policy and Promotion, CNPP-12; 2002.
8. American Diabetes Association. African American and diabetes facts [cited 2008 Jul 8]. Available from: <http://www.diabetes.org/communityprograms-and-localesvents/africanamerican/facts.jsp>.
9. AHA. Heart facts 2007: all Americans [cited 2008 Jul 21]. Available from: [http://www.americanheart.org/downloadable/heart/1176927558476AllAmAfAm%20HeartFacts07\\_lores.pdf](http://www.americanheart.org/downloadable/heart/1176927558476AllAmAfAm%20HeartFacts07_lores.pdf).
10. Winkleby MA, Robinson TN, Sundquist J, Kraemer HC. Ethnic variation in cardiovascular disease risk factors among children and young adults: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. *JAMA.* 1999;281:1006–13.
11. USDA and United States Department of Health and Human Services. Nutrition and your health: dietary guidelines for Americans, 2000. [5th ed. 2000; cited 2008 Jul 18]. Available from: <http://www.health.gov/dietaryguidelines/dga2000/document/>.
12. Slattery ML. Defining dietary consumption: is the sum greater than its parts? *Am J Clin Nutr.* 2008;88:14–5.
13. Kennedy ET, Ohls J, Carlson S, Fleming K. The Healthy Eating Index: design and applications. *J Am Diet Assoc.* 1995;95:1103–8.
14. McCullough ML, Feskanich D, Rimm EB, Giovannucci EL, Ascherio A, Variyam JN, Spiegelman D, Stampfer MJ, Willett WC. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in men. *Am J Clin Nutr.* 2000;72:1223–31.
15. McCullough ML, Feskanich D, Stampfer MJ, Rosner BA, Hu FB, Hunter DJ, Variyam JN, Colditz GA, Willett WC. Adherence to the Dietary Guidelines for Americans and risk of major chronic disease in women. *Am J Clin Nutr.* 2000;72:1214–22.
16. Feskanich D, Rockett HR, Colditz GA. Modifying the Healthy Eating Index to assess diet quality in children and adolescents. *J Am Diet Assoc.* 2004;104:1375–83.
17. Black MM, Bentley ME, Papas MA, Oberlander S, Teti LO, McNary S, Le K, O'Connell M. Delaying second births among adolescent mothers: a randomized controlled trial of a home-based mentoring program. *Pediatrics.* 2006;118:e1087–99.
18. Black MM, Papas MA, Bentley ME, Cureton P, Saunders A, Le K, Anliker J, Robinson N. Overweight adolescent African-American mothers gain weight in spite of intentions to lose weight. *J Am Diet Assoc.* 2006;106:80–7.
19. United States Department of Health and Human Services, Public Health Service. NHANES III anthropometric procedures [Videotape]. Washington, DC: U.S. Government Printing Office; 1996. (Stock No. 017–022–01335–5).
20. CDC. Body mass index [version current 2007 May 22; cited 2008 Jun 30]. Available from: <http://www.cdc.gov/nccdphp/dnpa/bmi/index.htm>.
21. Kamel EG, McNeill G, Van Wijk MC. Usefulness of anthropometry and DEXA in predicting intra-abdominal fat in obese men and women. *Obes Res.* 2000;8:36–42.
22. Park YW, Heymsfield SB, Gallagher D. Are dual-energy X-ray absorptiometry regional estimates associated with visceral adipose tissue mass? *Int J Obes Relat Metab Disord.* 2002;26:978–83.
23. Rockett HR, Breitenbach M, Frazier AL, Witschi J, Wolf AM, Field AE, Colditz GA. Validation of a youth/adolescent food frequency questionnaire. *Prev Med.* 1997;26:808–16.
24. Rockett HR, Colditz GA. Assessing diets of children and adolescents. *Am J Clin Nutr.* 1997;65:S1116–22.
25. Rockett HR, Berkey CS, Field AE, Colditz GA. Cross-sectional measurement of nutrient intake among adolescents in 1996. *Prev Med.* 2001;33:27–37.
26. Guenther PM, Reedy J, Krebs-Smith SM, Reeves BB, Basiotis PP. Development and evaluation of the Healthy Eating Index-2005: technical report [cited 2008 Jul 15]. Available from: <http://www.cnpp.usda.gov/Publications/HEI/HEI-2005/HEI-2005TechnicalReport.pdf>.
27. He Q, Horlick M, Fedun B, Wang J, Pierson RN Jr, Heshka S, Gallagher D. Trunk fat and blood pressure in children through puberty. *Circulation.* 2002;105:1093–8.
28. Langevin DD, Kwiatkowski C, McKay MG, Maillet JO, Touger-Decker R, Smith JK, Perlman A. Evaluation of diet quality and weight status of children from a low socioeconomic urban environment supports “at risk” classification. *J Am Diet Assoc.* 2007;107:1973–7.
29. Gibson RS. Principles of nutritional assessment. 2nd ed. New York: Oxford University Press; 2005.
30. National Center for Chronic Disease Prevention and Health Promotion. Body mass index-for-age. BMI is used differently with children than it is for adults [cited 2008 Sep 2]. Available from: <http://www.cdc.gov/nccdphp/dnpa/healthyweight/assessing/bmi/index.htm>.
31. National Academy of Sciences. Dietary Reference Intakes: recommended intakes for individuals [cited 2008 Sep 2]. Available from: <http://www.iom.edu/Object.File/Master/21/372/0.pdf>.