Relation between the Supplemental Nutritional Assistance Program cycle and dietary quality in low-income African Americans in Baltimore, Maryland[1–3]

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ABSTRACT

Background: There has been limited research regarding the Supplemental Nutritional Assistance Program (SNAP) and recipients' dietary quality during the days and weeks after benefit disbursement.

Objective: We examined the relation between participants' stages in the SNAP cycle and their macronutrient consumption, Healthy Eating Index (HEI) scores, and fruit and vegetable intake.

Design: In this cross-sectional study, we analyzed single 24-h dietary recalls collected from 244 African American SNAP participants recruited near 24 corner stores in Baltimore City. A multiple linear regression analysis and bootstrapping were used.

Results: Among participants who received a SNAP benefit ≤15 d before being surveyed, energy intake adjusted for minimum energy requirements (−4.49%; 95% CI: −8.77%, −0.15%) and HEI dairy scores (−0.12; 95% CI: −0.22, −0.01) were lower for each 1-d increase in the time since SNAP distribution (TSSD). Among participants who received SNAP benefits >15 d before being surveyed, energy intake (1.35%; 95% CI: 0.01%, 2.73%), energy intake adjusted for minimum energy requirements (3.86%; 95% CI: 0.06%, 7.96%), total fat intake (1.96%; 95% CI: 0.29%, 3.8%), saturated fat intake (2.02%; 95% CI: 0.23%, 4.01%), and protein intake (2.09%; 95% CI: 0.70%, 3.62%) were higher per each 1-d increase in the TSSD.

Conclusions: These findings suggest that the relation between the TSSD and macronutrient intake might be U-shaped, with higher intake of calories, fat, and protein in individuals in the very early and late stages of their SNAP cycles. Foods high in these nutrients might be cheaper, more accessible, and have a longer shelf-life than healthier options, such as fruit, vegetables, and whole grains, for SNAP participants when their benefits run out. Additional efforts are needed to investigate the effect of the TSSD on dietary intake by using a longitudinal design and to improve the quality of dietary intake in African American SNAP participants. *Am J Clin Nutr* 2014;99:1006–14.

INTRODUCTION

In 2012, 1 in 7 Americans received Supplemental Nutritional Assistance Program (SNAP)[4] benefits, previously known as the Food Stamp Program. SNAP aims to decrease food insecurity and increase the consumption of nutritionally adequate diets in low-income families. Several longitudinal studies have noted that SNAP participants, especially women, are more likely to become obese the longer they participate in the program than are eligible SNAP nonparticipants over the same time periods (1–3). In 2007, Dinour et al (4) proposed that such findings might be partially attributable to the SNAP cycle during which adult participants overeat for the first 3 wk of the cycle and then restrict their intake during the last week when their "resources have been depleted, followed by overeating when the monthly food stamp allotment has been resorted, and so on." The authors proposed that the SNAP cycle would affect individuals at all levels of food security, and food-security levels would vary depending on individuals' stage in the monthly SNAP cycle (4). This hypothesis was in part based on Electronic Benefit Transfer record data and the Continuing Survey of Food Intake by Individuals collected in the 1980s and 1990s in Maryland SNAP participants. Participants spent the majority of their benefits in the first week after the benefits were distributed (5), and caloric intake decreased during later parts of the "food stamp cycle" for SNAP participants who were only able to make one major food shopping trip per month (6).

There has been a lack of research regarding the relation between the SNAP cycle, dietary quality, and intake of macronutrients such as fats and protein. In the current study, we used a cross-sectional study design and sought to explore the relation between the individuals' stage in the SNAP cycle, macronutrient intake, and dietary quality in African Americans who were living in Baltimore City food deserts. We also propose an alternative to the previously stated SNAP hypothesis. We expected a U-shaped relation between participants' macronutrient consumption and

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[4] Abbreviations used: AIQ, Adult Impact Questionnaire; BHRR, B'More Healthy Retail Rewards; HEI, Healthy Eating Index; NDSR, Nutrition Data System for Research; SNAP, Supplemental Nutritional Assistance Program; TSSD, time since Supplemental Nutritional Assistance Program distribution.

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the time since SNAP distribution (TSSD). We hypothesized that participants have high energy intake soon after receiving SNAP benefits. However, we also hypothesized that their caloric and fat intakes decreases during the first 15 d after SNAP distribution, because participants are less food insecure and better able to afford healthier items such as fruit and vegetables. Then participants experience decreasing food security because of increasing TSSD. To make benefits last longer toward the end of the monthly cycle, we believed participants consume greater quantities of low-cost, low-nutrient, high-calorie, and high-fat food instead of consuming nutrient-rich foods, such as fruit and vegetables, which are more costly and have a shorter shelf life (4, 7–9).

SUBJECTS AND METHODS

The current study was conducted in low-income, predominantly African American neighborhoods in Baltimore City by using a cross-sectional survey design. This study used baseline data from the B'More Healthy Retail Rewards (BHRR) community intervention to examine the relation between the TSSD and quality of dietary intake. BHRR aims to improve the food environment in low-income communities (where ≥50% of residents have incomes <185% of the federal poverty level) by increasing the stock and promotion of healthy foods in local corner stores through pricing and communication strategies. Corner stores that participated in the BHRR intervention were located in neighborhoods characterized by limited access to healthy food options such as fruit and vegetables (10). Residents in these communities frequently purchase food from corner stores and carryouts (10, 11). Our previous study, which investigated the prevalence of food insecurity in Baltimore's low-income neighborhoods, revealed that 68% of respondents experienced food insecurity at the adult or children level (12). The BHRR study and data-collection materials were approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

Participant recruitment

Small stores were recruited in low-income areas of East and West Baltimore. Store customers were recruited near each of the 24 stores between May 2012 and September 2012. The sample size, which was calculated to assess the impact of the BHRR intervention, only called for 15 customer interviews per store. The first 15 eligible customers who expressed interest in the study were selected for interviews.

Participants were eligible for the study if they *1*) were African American adults and ≥21 y old, *2*) lived in the neighborhood near the store where they were recruited, *3*) shopped in the store at least 1 time/wk, and *4*) were the main food shopper for their household. Our research team screened participants for their eligibility, explained the purpose of the study, and obtained signed consent. All persons who were eligible agreed to be included in the study (n = 362). Participants were interviewed near stores where they were recruited. Questions were read aloud to control for low-literacy and to reduce nonresponse errors. All responses were recorded on paper forms by data collectors. Each interview lasted ∼1 h, after which respondents were compensated with a gift card.

We excluded participants from the analysis if they were not enrolled in the SNAP program at the time of the interview (n = 97), had total caloric intake below the 1st or above the 99th percentile of the sample mean (n = 7), had not used their benefits in the past 30 d (n = 3) or had missing data for that question (n = 5), did not report the date when they last received SNAP benefits (n = 4), or were <21 y of age (n = 2). *See* Supplementary Figure 1 under "Supplemental data" in the online issue for a flowchart. The final sample consisted of 244 individuals.

Data-collection instruments

Dependent variables

Twenty-four–hour dietary recall. Macronutrient consumption, estimated caloric intake, and fruit and vegetable consumption was assessed through a 24-h dietary recall. Data collectors used a 5-step multipass method to improve recall accuracy (13) and were aided by 60 culturally appropriate, 3-dimensional food models and common utensils to help participants estimate portion sizes. Data collection occurred on both weekdays and weekends. Dietary intake data were entered and analyzed by using Nutrition Data System for Research (NDSR) software (version 11; Nutrition Coordinating Center, University of Minnesota) (14). For consistency, a standardized procedure manual was developed by an NDSR specialist during data entry. NDSR output files were used to estimate total calorie, macronutrient, and food-group intakes.

Healthy Eating Index. Overall diet quality was evaluated by using the 2010 Healthy Eating Index (HEI) (15). The 2010 HEI is a tool developed by the USDA Center for Nutrition Policy and Promotion, and higher total HEI scores correspond to higher compliance with 2010 Dietary Guidelines for Americans (15). The maximum possible total HEI score is 100 points (15). Higher scores on refined grains and empty calorie components are indicative of low consumption of these dietary components, whereas higher HEI dairy and HEI whole-grain scores indicate higher consumption per 1000 cal. For example, the HEI dairy-component scores range from 0 to 5. A score of 5 represents consumption equivalent to ≥1.3 cups/1000 cal. In the current article, we only present total HEI scores and results from whole-grain, dairy, and refined-grain components of the HEI. We did not use the other components because we did not expect them to be related to the TSSD a priori, and the remaining HEI components were adequately represented through other dependent variables.

Food security. Food security over the past year was measured and scored by using the US Adult Food Security Survey Module (10 items) (16). Participants were asked to tell the interviewer whether statements about food situations presented in the module were "often true, sometimes true, or never true for you/your household in the past 12 months – that is, since [insert name of current month]." Food-security scores ranged from 0 to 10. A score of 0 indicated high food security, 1 or 2 indicated marginal food security, 3–5 indicated low food security, and ≥6 indicated very low food security.

Independent variable: Adult Impact Questionnaire

The Adult Impact Questionnaire (AIQ) was used in previous Baltimore Healthy Stores trials, and was modified for the purposes of this study (18). In this article, we focused on AIQ questions that assessed whether participants received SNAP benefits in the past 12 mo, the day of the month that participants received SNAP benefits, and the dollar amount of SNAP benefits participants spent in the past 30 d. The TSSD is the number of days between the date of the dietary recall and most-recent date participants reported having received SNAP benefits. For example, if a participant reported having received SNAP benefits on the fifth of every month, and the 24-recall took place on 20 October, the TSSD was calculated as 15 by subtracting the 2 dates 5 October from 20 October with Microsoft Excel 2010 software (Microsoft Corp). The TSSD was treated as a continuous variable. Additional post hoc analyses were conducted by using data related to participant's self-reported shopping frequencies at food sources such as supermarkets, wholesalers, and public markets in the 30 d before the interview.

Covariates

Other questions on the AIQ were used to ascertain participants' demographic information including the total number of people per household, food-purchasing behavior, and food security. Annual household income was assessed as a categorical variable, with values that ranged from 0 (income from \$0 to \$10,000) to 8 (income ≥\$80,001). There were a few individuals with household incomes >\$40,000, and for purposes of statistical analysis, these individuals were grouped together.

Participants' heights and weights were also collected by using a stadiometer and an electronic scale. Participants were instructed to take off their shoes and remove objects from their clothing that could affect their weight measurements. Height and weight measurements were taken ≥2 times. If the 2 readings for height measurements differed by ≥0.25 in or weight measurements differed by ≥0.2 lb, a third measurement was taken. Readings were later averaged together. Eighteen participants declined to have their heights measured, and 22 participants declined to have their weight measurements taken. For these individuals, self-reported heights and weights were used.

Participants' minimum required daily caloric intake needed to sustain energy expenditure compatible with normal life and weight maintenance was calculated by using equations of Schofield (17) for the basal metabolic rate, which accounted for age, weight, and sex, and was multiplied by the physical activity level value of 1.48 as recommended by Goldberg et al (18) for data with ≥200 participants and only one 24-h dietary recall.

Data collection

Data collectors were nutrition graduate students at the Johns Hopkins Bloomberg School of Public Health. Data collectors were trained by the principal investigator. The certification process required attendance of a 2-d data-collection training workshop. Furthermore, data collectors were required to observe an interview and administer interviews under the supervision of more-senior data collectors. After these steps were completed, data collectors were certified to conduct unsupervised interviews.

Data management

The completed questionnaire was reviewed immediately after the interview for completeness by the data collector. If data were missing, the data collector followed up with the participant to obtain the needed information. The completed questionnaire was checked for consistency by a different data collector ≤1 wk after the interview and was entered into a Microsoft Access 2010 database (Microsoft Corp).

Statistical analyses

Statistical analyses were conducted with STATA 12 software (19). On the basis of the Shapiro-Wilk test, the assumption of normality for macronutrient and energy intakes was violated. Thus, these outcomes were log transformed. After transformation, the Shapiro-Wilk test still indicated that the assumption of normality of error terms was likely to be violated. Therefore, multivariate linear regression analyses and bootstrapping with 2000 iterations were used to provide CIs that were robust to violations of this normality assumption.

Regression models controlled for age as a continuous variable, sex as a categorical variable, educational attainment as an ordinal variable (0 = less than high school, 1 = high school equivalent, and 2 = some college or beyond), and income ratio to the 2012 federal poverty threshold as a continuous variable. The federal poverty threshold was calculated on the basis of an estimated household income by taking the midpoint of participants' income category and dividing it by the 2012 federal poverty threshold. The poverty threshold was based on the number of household members, number of children <18 y old, and the respondent's age. The decision to control for these variables was made after developing a directed acyclic graph (*see* Supplemental Figure 2 under "Supplemental data" in the online issue) and finding the minimally sufficient set of covariates (20, 21). Household income was missing for 20 participants and was imputed on the basis of multiple linear regression results for the average income category on the basis of their age, sex, and education. The frequency of major shopping trips was treated as a continuous variable and calculated by adding frequencies of shopping at supermarkets, public markets, and wholesalers in the past 30 d.

A visual inspection of lowess smooth curves, which are locally weighted regressions (22, 23), indicated that the relation between the TSSD and dietary outcomes was nonlinear. Consequently, a spline term at day 15 was added to the models. This addition allowed the regression model to test whether the relation between dietary outcome variables and the TSSD varied depending on whether participants received their SNAP benefits ≤15 compared with >15 d before the interview.

For sensitivity analysis, we assessed whether results would substantively change had we used robust linear regressions, included participants with extreme values of caloric intake, only included food-insecure participants, only included women, controlled for a possible interaction between the TSSD and shopping frequency at major food sources, or used a quadratic instead of a spline term to model the nonlinearity between the TSSD and macronutrient intake.

RESULTS

Sociodemographics

Participants were 244 adults (125 women), with ages that ranged from 22 to 89 y (mean ± SD age: 47.6 ± 12.0 y) (**Table 1**). The most frequently self-reported annual household income range was

\$0–\$10,001/y (n = 109). With the exception of BMI values for women, no other differences were observed between individuals who received SNAP benefits ≤15 d before completing the dietary recall and those who received it >15 d before the interview.

Associations between TSSD and macronutrient intake

On average, participants' absolute intakes of energy, total fat, saturated fat, protein, and refined grain was high compared with estimated energy and macronutrient needs on the basis of the 2010 Dietary Guidelines for Americans, and whole-grain intake was low (**Table 2**). No group differences in unadjusted average macronutrient intakes and dietary quality were detected between participants who received SNAP benefits ≤15 compared with >15 d before being surveyed.

Results of the multivariable linear regression analysis of dietary intake and the TSSD are shown in **Table 3**. Estimated average macronutrient intake of participants on the 1st and 15th days of the SNAP cycle is also shown in Table 3 (*see* Supplementary Table 1 under "Supplemental data" in the online issue for unadjusted results). No statistical differences in macronutrient consumption were detected as a function of the TSSD among participants who received SNAP benefits ≤15 d before their dietary recall. However, the results were all in the expected direction, and estimated coefficients were not low. A post hoc analysis, which accounted for minimum required daily energy intake (needed to sustain energy expenditure compatible with normal life and weight maintenance), was also conducted. For this analysis, the outcome variable was computed by subtracting minimum required energy intake from the participant's total energy intake. The results indicated that caloric intake was 4.49% lower for each 1-d increase in the TSSD (95% CI: −8.77%, −0.15%) for individuals who were in the first 15 d of their monthly SNAP cycle. Results of unadjusted caloric intake were in the same direction but were not statistically significant (−1.34%; 95% CI: −3.06%, 0.40%).

Among participants were in the second half of their monthly SNAP cycle, energy intake was 1.35% higher (95% CI: 0.01%, 2.73%) per 1-d increase in the TSSD. This estimate changed to 3.86% (95% CI: 0.06%, 7.96%) after we accounted for participants' minimum estimated energy requirements. Participants also had 2.09% (95% CI: 0.70%, 3.62%) higher protein intake, 1.96% (95% CI: 0.29%, 3.8%) higher total fat intake, and 2.02% (95% CI: 0.23%, 4.01) higher saturated fat intake for every 1-d increase in the TSSD.

Associations between TSSD and intake of fruit and vegetables

No association was detected between the TSSD and fruit or vegetable intake (**Table 4**). However, on the basis of estimated coefficients, it appeared that, given a larger sample size, a drop in vegetable consumption per 1-d increase in the TSSD might have been detected in participants who were in the first 15 d of their monthly SNAP cycle.

TABLE 1
Sociodemographic characteristics of study participants[1]

	Whole sample	TSSD ≤15	TSSD >15	P
n	244	132	112	
Age (y)	47.6 ± 12.0[2]	47.7 ± 11.4	47.4 ± 12.5	0.91
BMI (kg/m^2)				
F	29.7 ± 9.0	31.6 ± 9.9	27.6 ± 7.4	0.02
M	25.9 ± 5.8	26.5 ± 6.0	25.1 ± 5.5	0.20
Adult food security (score)	2.9 ± 2.8	3 ± 2.9	2.7 ± 2.8	0.52
High [n (%)]	133 (54.5)	69 (52.3)	64 (57.1)	
Marginal [n (%)]	58 (23.8)	33 (25.0)	25 (22.3)	
Low [n (%)]	40 (16.4)	25 (18.9)	15 (13.4)	
Very low [n (%)]	11 (4.5)	5 (3.8)	6 (5.4)	
Missing	2 (0.8)	0 (0.8)	2 (1.8)	
F [n (%)]	125 (51.2)	65 (49.2)	60 (53.6)	0.24
WIC participation [n (%)]	42 (17.2)	22 (16.7)	20 (17.9)	0.50
Highest education obtained [n (%)]				0.60
Less than high school	91 (37.3)	52 (39.4)	39 (34.8)	
High school or GED	108 (44.3)	56 (42.4)	52 (46.4)	
Some college or associate's degree	34 (13.9)	18 (13.6)	16 (14.3)	
Bachelor's degree or graduate school	3 (1.2)	2 (1.5)	1 (0.9)	
Vocational school or other	8 (3.3)	4 (3.0)	4 (3.6)	
Household income [n (%)]				0.15
\$0–10,000	109 (44.7)	65 (49.2)	44 (39.3)	
\$10,001–\$20,000	56 (23.0)	24 (18.2)	32 (28.6)	
\$20,001– \$30,000	32 (13.1)	17 (12.9)	15 (13.4)	
\$30,001– \$40,000	17 (7.0)	10 (7.6)	7 (6.3)	
≥\$40,001	19 (7.8)	9 (6.8)	10 (8.9)	
Missing	11 (4.5)	7 (5.3)	4 (3.6)	

[1] Percentages shown represent column percentages. P values were calculated by using unadjusted logistic regression to test for differences in sociodemographic characteristics between individuals who received Supplemental Nutritional Assistance Program benefits ≤15 compared with >15 d before the dietary recall. TSSD, time since Supplemental Nutritional Assistance Program distribution; WIC, Supplemental Nutrition Program for Women, Infants, and Children.

[2] Mean ± SD (all such values).

TABLE 2
Unadjusted total caloric intake, macronutrient consumption, and HEI (2010) scores in study participants (n = 244)[1]

	TSSD ≤15 (65 F, 67 M)	TSSD >15 (60 F, 52 M)	P
Energy (kcal)			0.38
F	2957 (1146–7769)	3102 (606–8169)	
M	3602 (759–8696)	3616 (586–8033)	
Total kilocalories (minimum required)[2]			0.27
F	659 (−1633 to 4709)	949 (−1662 to 6021)	
M	1025 (−2022 to 5612)	1026 (−1968 to 5610)	
Empty calories			0.61
F	961 (88–3175)	1016 (107–3651)	
M	1183 (61–4173)	1223 (121–2981)	
Carbohydrate (g)			0.95
F	389 (127–1172)	401 (55–1108)	
M	447 (96–1146)	438 (122–912)	
Total fat (g)			0.47
F	107 (16–285)	116 (22–365)	
M	67 (20–339)	139 (1–439)	
Saturated fat (g)			0.53
F	34 (3–84)	37 (7–132)	
M	46 (7–128)	46 (0–138)	
Protein (g)			0.50
F	97 (22–342)	105 (18–391)	
M	119 (26–377)	123 (3–360)	
Fruit			0.12
F	3.2 (0–22)	1.8 (0–12)	
M	2.4 (0–18)	2.6 (0–12)	
Vegetables			0.78
F	3.9 (0–14.9)	3.3 (0–19.8)	
M	2.8 (0–14)	3.3 (0–12.6)	
HEI 2010			
Total score			0.20
F	55 (32–75)	51 (32–80)	
M	52 (27–73)	53 (36–72)	
Dairy			0.22
F	3.9 (0–10)	3.3 (0–10)	
M	4.8 (0–10)	4.4 (0–10)	
Refined grains			0.98
F	9.9 (8.3–10)	9.7 (7.2–10)	
M	9.7 (6.1–10)	9.9 (7.6–10)	
Whole grains			0.78
F	1.6 (0–10)	1.4 (0–10)	
M	1.6 (0–10)	1.6 (0–10)	

[1] All values are means; ranges in parentheses. P values were calculated by using unadjusted logistic regression to test for differences between individuals who received their Supplemental Nutritional Assistance Program benefits ≤15 compared with >15 d before the dietary recall. HEI, Healthy Eating Index; TSSD, time since Supplemental Nutritional Assistance Program distribution.

[2] Minimum required daily energy intake needed to sustain energy expenditure compatible with normal life and weight maintenance was calculated by using equations of Schofield (17) for the basal metabolic rate and multiplied by a physical activity level value of 1.48 as recommended by Goldberg et al (18) for data with ≥200 participants and only one 24-h recall.

Associations between TSSD and 2010 HEI scores

Results of the multivariate linear regression analysis of HEI scores and the time elapsed since SNAP distribution are shown in Table 4 (*see* Supplementary Table 2 under "Supplemental data" in the online issue for unadjusted results). HEI subcomponent scores suggested that the majority of participants had high refined-grain consumption and very low whole-grain consumption. In participants who received their benefits ≤15 d before the interview, the TSSD was associated with a small but significantly lower dairy HEI score per each 1-d increase in the TSSD (mean change per day: −0.12; 95% CI: −0.23, −0.01). No significant association was detected between the TSSD and total HEI scores or whole- and refined-grain components of the HEI score for participants with a TSSD >15 d. Post hoc analyses of remaining HEI scores were also performed (*see* Supplementary Table 3 under "Supplemental data" in the online issue). The analyses were indicative of low total fruit and vegetable intake and, in particular, the low consumption of dark greens, beans, and peas. The association between these outcomes and the TSSD were nonsignificant and were unlikely to become significant even if the sample size increased because of the low magnitude of the results and low variability in intake of these foods among our study participants.

TABLE 3
Association between TSSD and caloric and macronutrient intakes (*n* = 244)[1]

	Energy	Total kilocalories (minimum required)[2,3]	Empty kilocalories[3]	Carbohydrate	Total fat	Saturated fat	Protein
	kcal			*g*	*g*	*g*	*g*
On the first day after receiving SNAP benefits for men							
Mean	3144	1123	906	387	110	36	103
95% CI LL	2545	668	666	305	87	27	82
95% CI UL	3842	1,827	1196	486	139	46	127
On the first day after receiving SNAP benefits for women							
Mean	2660	1234	745	347	90	28	86
95% CI LL	2153	730	542	278	68	20	67
95% CI UL	3284	2074	1005	433	121	38	108
On the 15th day after receiving SNAP benefits for men							
Mean	2567	564	732	315	85	26	80
95% CI LL	2188	342	572	264	67	20	65
95% CI UL	3038	911	949	374	107	34	95
On the 15th day after receiving SNAP benefits for women							
Mean	2171	620	602	283	69	20	66
95% CI LL	1875	395	481	240	57	16	57
95% CI UL	2540	937	755	333	85	26	79
Change in intake per each 1-d increase in TSSD (%)							
If benefits received ≤15 d since SNAP-benefit distribution							
Mean	−1.34	-4.49[4]	−1.42	−1.36	−1.74	−2.03	−1.70
95% CI LL	−3.06	-8.77[4]	−3.75	−3.17	−4.04	−4.64	−3.53
95% CI UL	0.40	-0.15[4]	1.08	0.46	0.47	0.43	0.13
If benefits received >15 d since SNAP-benefit distribution							
Mean	1.35[4]	3.86[4]	1.43	1.00	1.96[4]	2.02[4]	2.09[4]
95% CI LL	0.01[4]	0.06[4]	−0.62	−0.52	0.29[4]	0.23[4]	0.70[4]
95% CI UL	2.73[4]	7.96[4]	3.38	2.57	3.80[4]	4.01[4]	3.62[4]

[1] Multivariable linear regressions were conducted by using bootstrapping and controlled for sex, age centered at 50 y, educational attainment category, and estimated poverty threshold to income ratio. Bias-corrected CIs are reported. A spline term with a knot on day 15 was included. Outcome variables were log transformed. Results of geometric means were converted back to the original scale. LL, lower limit; SNAP, Supplemental Nutritional Assistance Program; TSSD, time since Supplemental Nutritional Assistance Program distribution; UL, upper limit.

[2] Minimum required daily energy intake needed to sustain energy expenditure compatible with normal life and weight maintenance was calculated by using equations of Schofield (17) for the basal metabolic rate, which accounted for age, weight, and sex (17), and multiplied by a physical activity level value of 1.48 as recommended by Goldberg et al (18) for data with ≥200 participants and only one 24-h recall.

[3] Analyses performed post hoc.

[4] Estimates with CIs that do not overlap zero.

Food security

The average (±SD) food security score was 2.9 ± 2.8; 54.5% of participants had high food security, 23.8% of participants had marginal food security, 16.4% of participants had low food security, 4.5% of participants had very low food security, and 0.8% of participants had missing data. Among participants who received their SNAP benefits ≤15 d of being surveyed, the TSSD was slightly and negatively associated with annual food security (mean change per day: −0.10; 95% CI: −0.18, −0.02). No significant associations were detected between participants' annual food security and the TSSD in subjects who were interviewed >15 d after the receipt of SNAP benefits (mean change per day: 0.07; 95% CI: −0.01, 0.15).

Sensitivity analysis

Results obtained by using a linear model with a spline term on day 15 were plausible. Results did not change direction when we used a robust linear regression, only included women, or included participants with extreme caloric intake values. After we controlled for a possible interaction between the TSSD and shopping frequency at major food retailers (eg, supermarkets, wholesalers, and public markets), results increased in magnitude, and differences in energy intake as a function of the TSSD became significant. Results were in the expected direction but of a lower magnitude when we only included food-insecure participants (*n* = 109) in our analyses. Results of Aikaike Information Criterion tests and a visual inspection of boxplots of residuals showed that the model with spline terms performed nearly as well as the model that used a quadratic term.

DISCUSSION

To our knowledge, this was one of the first studies to examine the relation between the TSSD, macronutrient intake, and dietary quality of low-income African American adults. Results indicated that, among participants who received SNAP benefits ≤15 d before being surveyed, energy intake adjusted for minimum energy requirements and HEI dairy scores were lower for each 1-d increase in time elapsed since SNAP distribution. Among participants who received benefits >15 d before completing the 24-h dietary recall, caloric, protein, total fat, and saturated

TABLE 4
Association between TSSD, HEI scores, and fruit and vegetable consumption (n = 244)[1]

	HEI total score	HEI dairy	HEI refined grains	HEI whole grains	Fruit	Vegetables
					servings/d	*servings/d*
On the first day after receiving SNAP benefits for men						
Mean	54.6	5.6	9.8	2.4	2.7	3.0
95% CI LL	50.9	4.1	9.5	1.3	1.3	1.4
95% CI UL	58.6	7.0	10.0	3.7	4.3	4.5
On the first day after receiving SNAP benefits for women						
Mean	55.3	4.6	9.8	2.3	2.9	3.7
95% CI LL	51.5	3.2	9.6	1.0	1.6	2.1
95% CI UL	59.4	6.0	9.9	3.6	4.4	5.4
Change in intake per each 1-d increase in TSSD						
If benefits received ≤15 d since SNAP-benefit distribution						
Mean	−0.28	−0.12	0.00	0.00	−0.04	−0.11
95% CI LL	−0.61	−0.23	−0.01	−0.11	−0.17	−0.24
95% CI UL	0.03	−0.01	0.02	0.09	0.07	0.00
If benefits received >15 d since SNAP-benefit distribution						
Mean	0.10	0.04	0.00	−0.03	−0.03	0.08
95% CI LL	−0.17	−0.06	−0.02	−0.10	−0.12	−0.01
95% CI UL	0.39	0.14	0.01	0.05	0.07	0.18

[1] Multivariable linear regressions were conducted by using bootstrapping, and adjusted results were obtained by controlling for sex, age centered at 50 y, educational attainment category, and estimated poverty threshold to income ratio. Bias-corrected CIs are reported. A spline term on day 15 was included. Higher total HEI scores correlate to higher compliance with the 2010 Dietary Guidelines for Americans. Higher scores on refined-grain and empty-calorie component indicated low consumption, and higher scores on the dairy and whole-grain components indicated higher consumption per 1000 cal. For example, the HEI dairy–component scores ranged from 0 to 5. A score of 5 represented consumption equivalent to ≥1.3 cups/1000 cal. HEI, Healthy Eating Index; LL, lower limit; SNAP, Supplemental Nutritional Assistance Program; TSSD, time since Supplemental Nutritional Assistance Program distribution; UL, upper limit.

fat intakes increased per each 1-d increase in the TSSD. Foods high in fat might be cheaper and have a longer shelf-life than healthier foods such as fruit, vegetables, and whole grains (4, 7–9, 24) and might be more accessible to SNAP participants when their benefits run out at the end of the monthly SNAP cycle.

Energy intake results differed from those obtained in a previous longitudinal study that used electronic benefit transfer data collected from 1989 to 1991 (6). Results of the study showed that energy intake was stable throughout the month for Maryland participants who were able to make major shopping trips often but decreased during the fourth week of the SNAP cycle for participants who only made one major shopping trip per month (6). Differences in findings might have been a result of differences in study designs or study populations. Our participants were recruited near corner stores in low-income neighborhoods in Baltimore City. When we controlled for the possible interaction between the TSSD and frequency of shopping trips to major food source, the association between energy intake and the TSSD became significant, increased in magnitude, and was still indicative of a U-shaped relation between energy intake and the TSSD. Therefore, it is unlikely that differences between our results and those shown in the previous study in Maryland were related to the shopping frequency at major food retailers.

We relied on a single 24-h recall for our dietary intake measure, which was expected to produce unbiased means but artificially large estimates of variation, particularly for micronutrients. Therefore, we limited our analysis to macronutrients and food groups (25). Although the regression analysis of the relation between the TSSD and macronutrient intake produced results that were in the expected direction on the basis of our hypothesis, because of a relatively small sample size and large SEs, additional significant results might not have been detected.

On average, women and men consumed 3027 and 3608 kcal/d, respectively. Approximately one-third of calories were empty calories. This amount was higher than the average 1979-kcal intake of a nationally representative sample of SNAP participants (26). In addition, a 2%/d increase in total and saturated fat intakes associated with the TSSD is troubling. This amount equates to nearly a 29-g increase in total fat intake and a 9-g increase in saturated fat intake over the third and fourth weeks after SNAP-benefit distribution. The higher total fat and saturated fat intakes associated with the TSSD might have been a result of the more-frequent consumption of low nutrient- and high energy-dense foods during the second half of the monthly SNAP cycle. SNAP participants may opt for nutrient-poor, energy-dense foods because these foods have a longer shelf-life, are more affordable, and more available in their communities (4, 7–9, 24).

Results of this study suggested that 2010 HEI scores, which serve as indicators of dietary quality, did not depend on the TSSD in participants in our sample. The majority of participants had very low whole-grain consumption and high refined-grain intake irrespective of the TSSD. One possible reason that differences in HEI scores were not detected between the 2 groups of participants was because of the low variability of HEI scores. Data from a nationally representative sample of SNAP participants indicates that very few participants met dietary recommendations for fruit, vegetables, grains, fish, and plant-based protein intake and consumed higher quantities of processed foods such as meats and refined grains than did SNAP nonparticipants (26). These findings highlight the need to develop new strategies to support the consumption of healthier food among SNAP participants at all stages of their monthly SNAP cycle.

Note that only 55.3% of participants in this study had high food security; this percentage was much lower than expected on the basis of estimates from state (12.5% in 2009–2011) and national survey data (27). Our findings are supported by previous research that examined food security in low-income communities in East and West Baltimore and suggest that SNAP was not adequately improving participants' food security (12). Because our study examined food security over the past year, it was not possible to assess food security variations that occurre throughout the SNAP cycle and their relationship to macronutrient intake and dietary quality. The slightly negative association between TSSD and annual food security in participants who received SNAP ≤15 d before the interview was unexpected. This association might have been attributable to inaccuracies in the food-security recall, whereby the recall of respondents food security status for the entire 12 mo was based on their current food security.

Several limitations of this study should be noted. This study used a cross-sectional design. Longitudinal studies are also needed to assess whether the TSSD would have the same associations with nutritional intake if multiple dietary assessments per SNAP participant were administered over the course of the SNAP cycle. However, with the exception of BMI in women (which was lower among participants with a TSSD >15 d), participants surveyed in the first 15 d of their food-stamp cycle were not different from participants surveyed in last 15 d of their cycle on the basis of measured characteristics. We believed that it was unlikely that the 2 groups differed in additional unmeasured characteristics because the TSSD was distributed fairly evenly though the possible range of values, and interviews also took place during all weeks of the data-collection period. In addition, if BMI was a confounder because of its relation with energy intake, results of our analysis would have moved closer to the null after accounting for minimum energy intake needed to sustain current weight and preform daily activities. Instead, after we conducted a post hoc analysis, the association between the TSSD and energy intake was even stronger than when energy intake was left unadjusted. Another study limitation was that we only had data on the timing distribution of SNAP benefits, but we did not have a data-related distribution timing of other income sources. We expected that most participants made food purchases predominantly by using SNAP and used other sources of income to cover rent, utilities, and other expenses. However, we were not able to test this assumption empirically.

Additional research is also needed to determine whether the relation between the TSSD, macronutrient intake, and dietary quality is different for SNAP participants who live in rural communities or between women and men. On the basis of a visual inspection of our data, it appeared that the relation between the TSSD and dependent variables examined in this study was weaker for men than women. However, to detect this potential interaction, a much-larger sample size was needed. Previous research has suggested that the BMI of men might be less affected by the SNAP cycle than is the BMI of women (28).

In conclusion, much more research is needed to find effective ways to *1*) improve nutritional intake in SNAP participants throughout the month by making healthy, nutrient-rich foods more available and affordable, *2*), increase the demand and consumption of those foods, and *3*) increase the food security among African American SNAP recipients. This undertaking will require collaborations in stakeholders at multiple levels of the food system.

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