Fruit and Vegetable, Fat, and Sugar-Sweetened Beverage Intake Among Low-Income Mothers Living in Neighborhoods With Supplemental Nutrition Assistance Program—Education

Fred Molitor, PhD1,4; Sharon B. Sugerman, MS, RD2; Stan Sciortino, PhD, MPH3

ABSTRACT

Objective: To examine among low-income mothers the consumption of fruits and vegetables (FV), high-fat foods, and sugar-sweetened beverages (SSBs) and overall diet quality in relation to levels of reach of Supplemental Nutrition Assistance Program—Education (SNAP-Ed) interventions across 2,907 California census tracts.

Design: Cross-sectional telephone survey conducted from April through October, 2014 using the Automated Self-administered 24-Hour Recall dietary assessment.

Participants: Mothers or primary caregivers (n = 6,355) from randomly selected SNAP households. The sample was 42.6% Latina, 25.5% white, and 17.6% African American. The response rate was 60.5%.

Main Outcome Measures: Cups of FV; calories from high-fat foods; and cups of SSBs, overall and from items purchased from fast-food restaurants. Overall diet quality was assessed by the Healthy Eating Index—2010.

Analysis: Linear regression controlling for race/ethnicity and education, with significance at P ≤ .05.

Results: Mothers from high SNAP-Ed reach census tracts ate more cups of FV, consumed fewer calories from high-fat foods, and drank fewer cups of SSBs. Healthy Eating Index—2010 scores did not vary by levels of SNAP-Ed reach.

Conclusions and Implications: Supplemental Nutrition Assistance Program—Education interventions are related to increased intake of FV and decreased consumption of high-fat foods and SSBs, but not overall diet quality. Future studies should include assessment of physical activity to investigate caloric balance in association with levels of SNAP-Ed interventions.

Key Words: fruit, vegetable, SNAP-Ed, ecological, 24-hour recall, nutrition education, mother, fat, sugar-sweetened beverage (J Nutr Educ Behav. 2016;■:1-8.)

INTRODUCTION

The US Department of Agriculture (USDA) Supplemental Nutrition Assistance Program—Education (SNAP-Ed) is the most widespread program designed to promote and possibly change behaviors in support of healthy lifestyles among low-income populations in the US. Supplemental Nutrition Assistance Program—Education nutrition and physical activity interventions are aimed at persons within households with an income at or below 185% of the federal poverty level, who are defined by the USDA as SNAP eligible, which in federal fiscal year (FFY) 2014 exceeded 46.5 million.1 Mothers are a primary target population for such interventions because they are the persons from SNAP households most likely to be responsible for the purchase of food and preparation of meals, and serve as role models for children’s eating habits.2

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life styles consistent with the current Dietary Guidelines for Americans, interventions in California are mostly or entirely nutrition focused. In fact, when the USDA has initiated studies to test the effectiveness of SNAP-Ed, the selected interventions have addressed only dietary behaviors, with fruit and vegetable consumption serving as the primary outcome variable. These highly controlled, high-dose interventions have found increased fruit and vegetable consumption resulting from SNAP-Ed.

Observational studies designed to test associations between SNAP-Ed and increased fruit and vegetable intake would offer greater generalizability of the efficacy of such interventions. However, assessment of the independent variable would be problematic because most SNAP-Ed participants would not know when asked whether a particular intervention in which they participated was SNAP-Ed affiliated; service providers are not required and do not explicitly identify their interventions as SNAP-Ed.

The ecological study design addresses this problem by comparing summary statistics of outcome measures from individuals within groups in relation to exposures available at the same aggregate level. This approach has been used to show that the incidence of human immunodeficiency virus decreased over time within 81 cities with needle exchange programs and increased within 52 cities without such programs, and to demonstrate relationships between increased body mass index (calculated from self-reported height and weight) and living closer to fast-food restaurants and convenience stores.

One study that used the ecological research approach to evaluate SNAP-Ed found that low-income California adults living in census tracts with higher levels of SNAP-Ed intervention reach, defined as the number of SNAP-Ed recipients over the number of SNAP-Ed–eligible persons, reported an increased frequency of consumption of fruits and vegetables. One strength of this study over previous research was that the independent variable was based on the diverse types and intensities of SNAP-Ed interventions implemented throughout California. This study also found the frequency of eating fast-food and levels of SNAP-Ed reach to be negatively related, which suggested that such interventions increase the intake of fruits and vegetables and reduce the intake of unhealthful foods.

Reducing the consumption of unhealthful beverages in addition to unhealthful foods is a focus of SNAP-Ed interventions in California. The statewide Rethink Your Drink campaign provides educational messages and materials for recognizing beverages with added sugar and the link between sugar-sweetened beverages and health risks. In FFY 2014, California SNAP-Ed service providers reported that 16% of the over a half-million SNAP-Ed recipients participated in direct education interventions that included Rethink Your Drink messages and materials (E. Talmage, unpublished data, 2015).

The objective of the current ecological study of low-income mothers was to examine levels of reach of SNAP-Ed interventions across California census tracts in relation to dietary intake and overall diet quality. Specifically, consumption of fruits and vegetables; high-fat, fast-food type foods; and sugar-sweetened beverages, overall and for purchases from fast-food restaurants, were hypothesized to correlate significantly with levels of SNAP-Ed intervention reach. Scores for the Healthy Eating Index–2010 (HEI–2010), a valid and reliable measure of diet quality in accordance with the recommendations of the Dietary Guidelines for Americans, 2010, were also examined in relation to SNAP-Ed intervention reach. Higher levels of SNAP-Ed reach and HEI–2010 scores would provide empirical evidence that such interventions are related to overall dietary behaviors and not only to the intake of selected types of healthful and unhealthful items.

**METHODS**

**Sample and Recruitment**

The study population represented the target population for SNAP-Ed interventions: mothers (or primary caregivers) of children. The sampling frame was the California Department of Social Services, Medi-Cal Eligibility Data System, a database that is updated quarterly with the names, contact information, and limited demographics such as age for persons from households receiving SNAP throughout California. Sampling procedures involved the random selection of households with at least 1 adult woman and 1 child aged 5–17 years from the 17 largest California local health departments (LHDs).

Recruitment procedures began with letters of introduction sent to mothers or addressed to the youngest adult woman in households with > 1 adult woman, as identified in the Medi-Cal Eligibility Data System. This step was taken to increase the chance that the letters would be received by mothers with children aged < 18 years. Next, telephone calls were conducted to confirm study eligibility, interest in participation, primary language, and contact information. Mothers were offered a $10 incentive to participate in a telephone survey scheduled for a later date. This study was reviewed and approved by the California Health and Human Services Agency, Committee for the Protection of Human Subjects.

**Survey**

The Automated Self-administered 24-Hour Recall (ASA24) was used to assess dietary behaviors. Trained interviewers from the organization that developed the ASA24 with the National Cancer Institute used the Web-based system to administer the dietary assessment by telephone in English or Spanish. Before the ASA24 interview, mothers who expressed interest in participating in the survey during the initial screening and recruitment telephone calls were sent measuring cups and spoons and a Size Up Your Portion: A Guide to Food Serving Sizes booklet. During the subsequent telephone survey the interviewers referenced the cups, spoons, and portion-size images from the booklet to assist mothers in selecting the precise amount of each food and beverage they recalled consuming for each meal during the past 24 hours. Information such as cooking methods, added items such as condiments, and place of purchase was also recorded when applicable.

The ASA24 does not include demographic questions; survey participants'
race/ethnicity, highest level of education, and age were recorded on a separate instrument. Interviews were conducted from April through October, 2014. The response rate was 60.5% (American Association for Public Opinion Research RR4).13

Outcome Measures

The 4 dietary outcome variables of this study as derived from the ASA24 interviews were: (1) cups of fruits (whole and 100% juice) and vegetables; (2) cups of sugar-sweetened beverages, full or low sugar; (3) calories from high-fat, fast-food–type foods; and (4) HEI-2010 scores. The first 2 variables were created by examining the frequencies of the ASA24 codes for whole fruits and 100% juice, total vegetables, and sugar-sweetened beverages with sugar, and then converting and summing the associated quantities into cups. A total of 75 high-fat food items frequently purchased from fast-food settings were identified in the ASA24 database by the study senior nutritionist (second author) and included battered/breaded and/or fried vegetables (onions, okra, mushrooms, and white potatoes), battered/breaded and/or fried fish, seafood, and chicken prepared with the skin or without skin, including breaded chicken products (nuggets, patties, or fingers); hamburgers, including cheese and/or bacon; egg sandwiches (muffin, bagel, or biscuit) with cheese, bacon, and/or sausages; and hotdogs or other processed meat products such as sausages and bacon. The calories of these items along with related condiments (dressing, mayonnaise, or ketchup) were calculated based on the reported portion size, and summed.

The HEI-2010 scores (theoretical range of 0–100) were calculated from published scoring procedures.10 The HEI-2010 does not represent a mutually exclusive outcome for this study because the 12 dietary components on which overall scores are calculated include total fruit, whole fruit, and total vegetables, as well as calories from solid fats and added sugars, including those obtained from sugar-sweetened beverages. The researchers selected HEI-2010 as a distinct outcome because it represents a measure of overall diet quality in accordance with the recommendations of the Dietary Guidelines for Americans, 2010.11

Demographics

To assess race/ethnicity, mothers were asked the following questions on the supplemental questionnaire: What is your race? You may choose > 1. Are you American Indian or Alaska Native, Asian, black or African American, Native Hawaiian or other Pacific Islander, or white? and Are you Hispanic, Latina, or of Spanish origin? Highest level of education was measured by asking, What is the highest level of school you have completed or the highest degree you have received? Mothers were presented with the following response options: grade ≤ 8; grade 9–12; high school graduate or General Educational Development completed; some vocational, trade, or business school but no diploma; completed a vocational, trade, or business school program; some college credit but no degree; college graduate; or postgraduate or professional degree. Mothers’ age was calculated as the difference between interview and birth dates, or for those who refused to provide a date of birth, from the question, What is your age?

Analytic Database

The ASA24 data were obtained from 6,915 mothers (Figure). A total of 90 respondents were subsequently excluded because of partial interviews or because they reported fasting during the previous 24 hours. Total caloric intake above 3 SDs from the mean (4,500 cal; n = 70 mothers) were considered improbable high values and were excluded from analysis. Because caloric intake was skewed to the right and no transformations allowed for clear lower cut points, 600 cal was used, as recommended by the National Cancer Institute based on the National Health and Nutrition Examination Survey data set,14 as the criterion to remove 400 records.

The addresses provided by the remaining 6,355 mothers (or zip codes for 13 mothers without a full address) were geocoded to 2,907 census tracts. The SNAP-Ed intervention reach was then calculated within each census tract as a proportion based on the total number of unduplicated SNAP-Ed direct education participants divided by the number of SNAP-Ed–eligible persons for FFY 2014.

Numerators for calculating SNAP-Ed intervention reach were based on the numbers of SNAP-Ed participants aged 5–59 years receiving direct education as reported in the USDA Education and Administrative Reporting System (EARS) by LHD staff and their subcontractors who implemented SNAP-Ed in California in FFY 2014. Direct education is defined as a structured nutrition education lesson(s) provided by an instructor for at least 15 minutes. Minors were included in the numerator because many SNAP-Ed interventions aimed at children and teenagers include materials and messages for their parents.

The EARS data contain duplicated counts of SNAP-Ed participants, in part because different agencies within an LHD may enter information about the same SNAP-Ed participants, or because attendees of multiple-session interventions are entered more than once. Staff members from the Nutrition Education and Obesity Prevention Branch, California Department of Public Health, implement various processes to identify and remove duplicate SNAP-Ed participant counts. These include retaining only the information for participants of the first event for ongoing interventions with the same name, and identifying redundant entries after sorting interventions by site name within cities. Denominators for calculating SNAP-Ed intervention reach (the number of SNAP-Ed–eligible persons aged 6–65 years within each of the 2,907 census tracts) were based on standardized procedures using data from the US Census and American Community Survey.15 Distribution of SNAP-Ed intervention reach across the 2,907 census tracts was highly skewed to the right of its mean of 0.061 (skewness = 7.73). Because of this distribution, and for ease of interpretability of the study findings, categorical variables were created representing levels of intervention reach. The distribution of the data also limited the options for the number of categories. Initially a high then a moderate reach variable were developed with cutoff points for each dichotomous variable determined to ensure that sufficient
statistical power was available for comparison with a referent group. Specifically, proportions > .25 were coded as high reach and values > .10 and ≤ .25 were classified as moderate reach.

A total of 475 and 487 mothers lived in high- and moderate-reach groups, respectively. Mothers from low-reach census tracts (n = 1,394) were grouped with the 3,999 mothers from no-reach census tracts to represent the referent group for the analyses because having < 10% of the SNAP-Ed population participating in a SNAP-Ed intervention was considered too low to have a measurable effect.

Data Analysis

Mothers’ responses to the race/ethnicity questions were coded into 4 categories: Latina (Hispanic, Latina, or of Spanish origin); white, non-Hispanic; African American, non-Hispanic; or other. Four categories were also created for highest level of education: less than high school graduate; high school graduate; vocational schooling or some college courses; or college graduate. Table 1 presents descriptive statistics for these variables and age. The distributions of the demographic variables are also shown in Table 1 by levels of SNAP-Ed intervention reach. Although not a primary research question of this study, statistical tests (chi-square tests of independence for race/ethnicity and education and 1-way ANOVA for age) were performed because support for the null hypotheses would suggest that SNAP-Ed interventions are equivalently distributed to low-income mothers regardless of race/ethnicity, age, or education.

Unfortunately, a number of ASA24 interviews concluded without administration of the supplemental questionnaire, which resulted in race/ethnicity, age, and education not being recorded for 8.2%, 8.1%, and 5.8% of mothers, respectively. Missing data were handled in the analyses of the independent and outcome variables as follows: The proportions for valid vs missing responses for each demographic were examined by levels of SNAP-Ed intervention reach using chi-square tests. In these cases, support for the null hypotheses would suggest that the lost demographic information was random. For the analyses to test the central research questions of this study, missing data were included in the series of dummy variables for the covariates of race/ethnicity and education.

Separate linear regression models were developed for each outcome variable using 2 dummy variables for SNAP-Ed reach: moderate reach (no/low reach = 0; moderate reach = 1; and high reach = 0) and high reach (no/low reach = 0; moderate reach = 0; and high reach = 1), thus making no/low reach the reference group. For race/ethnicity, dummy variables for Latina, African American, other, and missing cases were compared with the reference group representing whites. For education, mothers with vocational or college education served as the reference group for dummy variables for less than high school education, high school graduate, and missing cases.

Table 2 presents the unadjusted means for the dietary intake variables and HEI-2010 scores, as well as constants for each regression model representing the adjusted mean for the no/low SNAP-Ed reach group. Beta coefficients indicate the magnitude of change for the outcome measures for the moderate and high SNAP-Ed reach groups.

Models for cups of fruits and vegetables, calories from high-fat foods,
and cups of sugar-sweetened beverages were repeated, but only for items purchased from fast-food restaurants using the same covariates. The HEI-2010 scores were computed using SAS code (version 9.3, SAS Institute, Inc, Cary, NC, 2013). All descriptive and inferential statistical analyses were conducted using SPSS Statistics for Windows (version 20.0, IBM Corp, Armonk, NY, 2011). The criterion for statistical significance was set at $P < .05$.

**RESULTS**

The sample of SNAP mothers was 42.6% Latina, 25.5% white, and 17.6% African American (Table 1). Mean age of mothers was 37.5 years (SD, 8.1 years). One-fifth of the sample (19.8%) reported their education at less than a high school graduate level. Highest level of education included vocational or some college coursework but not a college degree for 38.4% of the sample; 12.6% of mothers were college graduates. Nonsignificant differences between valid and missing data indicated that lost demographic information was random. The distribution of valid responses to the race/ethnicity, age, and education items also did not differ significantly by no/low, moderate, and high SNAP-Ed reach levels, which suggested the equitable availability of such interventions for low-income mothers in the selected 17 California LHDs.

Overall, SNAP mothers reported eating a mean of 3.04 cups of fruits and vegetables, consuming 100.2 cal from high-fat, fast-food-type foods, and drinking 1.18 cups of sugar-sweetened beverages during the previous 24 hours (Table 2). Reported consumption of fruits and vegetables and sugar-sweetened beverages from fast-food restaurants was limited, 0.091 and 0.122 cups, respectively. Mothers consumed on average 30.8 cal from high-fat, fast-food restaurant purchases. The mean HEI-2010 score for the sample was 54.1.

Levels of self-reported intake did not differ between mothers from moderate vs no/low SNAP-Ed intervention reach census tracts. However, mothers from high SNAP-Ed reach compared with no/low SNAP-Ed reach census tracts reported eating significantly greater quantities of fruits and vegetables (0.304 cups), consuming 34.6 fewer calories from high-fat foods, and drinking 0.171 fewer cups of sugar-sweetened beverages. For items purchased at fast-food restaurants, higher SNAP-Ed reach was related to more cups of fruits and vegetables and fewer calories from high-fat foods, but was not associated with the number of reported cups of sugar-sweetened beverages.

The adjusted mean HEI-2010 score for mothers from no/low SNAP-Ed reach areas was 50.6; means for mothers from moderate and high SNAP-Ed reach census tracts were 49.4 and 51.9, respectively. The relationship between levels of SNAP-Ed intervention reach and overall diet

<table>
<thead>
<tr>
<th>Demographic</th>
<th>Total</th>
<th>No/Low</th>
<th>Moderate</th>
<th>High</th>
<th>Valid vs Missing Responses ($P$)</th>
<th>Valid Responses ($P$)</th>
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</thead>
<tbody>
<tr>
<td>Mothers, n (%)</td>
<td>6,355</td>
<td>5,393 (84.9)</td>
<td>487 (7.7)</td>
<td>475 (7.5)</td>
<td>520 (8.2)</td>
<td>446 (85.8)</td>
</tr>
<tr>
<td>Race/ethnicity</td>
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<tr>
<td>Latina, n (%)</td>
<td>2,705 (42.6)</td>
<td>2,276 (84.1)</td>
<td>234 (8.7)</td>
<td>195 (7.2)</td>
<td>.83</td>
<td>.12</td>
</tr>
<tr>
<td>White, n (%)</td>
<td>1,619 (25.5)</td>
<td>1,398 (86.3)</td>
<td>103 (6.4)</td>
<td>118 (7.3)</td>
<td>.12</td>
<td>.83</td>
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<tr>
<td>African American, n (%)</td>
<td>1,117 (17.6)</td>
<td>940 (84.2)</td>
<td>87 (7.8)</td>
<td>90 (8.1)</td>
<td>.12</td>
<td>.83</td>
</tr>
<tr>
<td>Other, n (%)</td>
<td>394 (6.2)</td>
<td>333 (84.5)</td>
<td>26 (6.6)</td>
<td>35 (8.9)</td>
<td>.12</td>
<td>.83</td>
</tr>
<tr>
<td>Missing, n (%)</td>
<td>520 (8.2)</td>
<td>446 (85.8)</td>
<td>37 (7.1)</td>
<td>37 (7.1)</td>
<td>.12</td>
<td>.83</td>
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<tr>
<td>Age, y</td>
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<td>Valid, n (%)</td>
<td>5,840 (91.9)</td>
<td>4,951 (84.8)</td>
<td>450 (7.7)</td>
<td>439 (7.5)</td>
<td>.82</td>
<td>.42</td>
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<td>Missing, n (%)</td>
<td>515 (8.1)</td>
<td>442 (85.8)</td>
<td>37 (7.2)</td>
<td>36 (7.0)</td>
<td>.12</td>
<td>.42</td>
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<tr>
<td>Mean (SD)</td>
<td>37.5 (8.1)</td>
<td>37.5 (8.1)</td>
<td>37.5 (8.1)</td>
<td>37.2 (8.0)</td>
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<td>Education</td>
<td></td>
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<tr>
<td>Less than high school graduate, n (%)</td>
<td>1,256 (19.8)</td>
<td>1,048 (83.4)</td>
<td>112 (8.9)</td>
<td>98 (7.6)</td>
<td>.89</td>
<td>.45</td>
</tr>
<tr>
<td>High school graduate, n (%)</td>
<td>1,485 (23.4)</td>
<td>1,260 (84.8)</td>
<td>108 (7.3)</td>
<td>117 (7.9)</td>
<td>.89</td>
<td>.45</td>
</tr>
<tr>
<td>Vocational or some college, n (%)</td>
<td>2,442 (38.4)</td>
<td>2,082 (85.3)</td>
<td>182 (7.5)</td>
<td>178 (7.3)</td>
<td>.89</td>
<td>.45</td>
</tr>
<tr>
<td>College graduate, n (%)</td>
<td>801 (12.6)</td>
<td>686 (85.6)</td>
<td>59 (7.4)</td>
<td>56 (7.0)</td>
<td>.89</td>
<td>.45</td>
</tr>
<tr>
<td>Missing, n (%)</td>
<td>371 (5.8)</td>
<td>317 (85.4)</td>
<td>26 (7.0)</td>
<td>28 (7.5)</td>
<td>.89</td>
<td>.45</td>
</tr>
</tbody>
</table>

SNAP-Ed indicates Supplemental Nutrition Assistance Program–Education.

Note: SNAP-Ed Intervention Reach represents the number of SNAP-Ed recipients divided by the SNAP-Ed–eligible population per census tract: no/low, 0 to $\leq 0.10$; moderate, $> 0.10$ to $\leq 0.25$; high, $> 0.25$ to 1.0. Tests of significance across levels of SNAP-Ed intervention reach for valid vs missing responses are based on chi-square tests of independence. Tests of significance for race/ethnicity and education by SNAP-Ed intervention reach are based on chi-square tests of independence; 1-way ANOVA was used for age.
DISCUSSION

The central focus of SNAP-Ed in California, as communicated by the Nutrition Education and Obesity Prevention Branch, California Department of Public Health, to LHDs that implement and oversee related interventions, is knowledge transfer of the health benefits of fruits and vegetables; planning, purchasing, and preparing healthful snacks and meals; healthful recipes; the recommended intake of fruits and vegetables per the USDA’s MyPlate guidelines; and reducing the intake of saturated fats as well as sugar, overall and specifically from sugar-sweetened beverages.

Accordingly, the current study found support for the hypothesized relationship between SNAP-Ed and the reported consumption of fruits and vegetables among low-income mothers. Moreover, the 0.304-cup difference in fruit and vegetable intake for mothers from high vs no/low SNAP-Ed reach census tracts met the criterion used by researchers to regard SNAP-Ed interventions as effective: that is, of having a measurable impact on health.5,6

This finding is in line with experiments involving SNAP-Ed-eligible adults;16–18 intervention participants increased intake of fruits and vegetables by 0.41–0.52 cups. These experimental outcomes came from highly structured, multiple-lesson or multiple-workshop nutrition education interventions. In 1 study,16 for example, increased fruit and vegetable consumption was reported from those who had previously attended ≥1 30-minute workshops conducted at farmers’ markets consisting of instruction by a nutritionist or registered dietitian, cooking demonstrations using seasonal fruits and vegetables, and the distribution of recipes and a $2 coupon toward the purchase and fruits and vegetables. The finding for the current study, in contrast, was based on SNAP-Ed interventions delivered for at least 15 minutes, under conditions not as controlled as those found in experiments, by instructors with varying levels of education, training, experience, and skills. As such, the current and past6 ecological studies contribute to the literature by suggesting that different direct education SNAP-Ed interventions conducted in a number of settings by instructors with varying backgrounds can increase fruit and vegetable intake to levels that, although not as foundational as those reported from experimental research, are conducive to improved health outcomes. Furthermore, such outcomes appear to be generalizable to low-income populations at a statewide level, including those from predominantly Spanish-speaking communities.

The current study also demonstrated relationships between SNAP-Ed and decreased intake of calories from high-fat, fast-food-type foods and sugar-sweetened beverages. Furthermore, the study findings suggest that SNAP-Ed provides low-income mothers with the knowledge and skills to eat more healthy foods when ordering from fast-food restaurants. Specifically, correlational analyses found that mothers living in census tracts with higher levels of SNAP-Ed interventions ate greater quantities of fast-food restaurant-purchased fruits and vegetables and consumed fewer calories from high-fat foods from fast-food restaurants than did mothers from census tracts with no or limited SNAP-Ed interventions.

Yet, HEI-2010 scores were not associated with levels of SNAP-Ed intervention reach. Participants of SNAP-Ed may be compensating for these changes in diet by preparing, ordering, and consuming more quantities of other types of foods such as full-fat dairy

### Table 2. Intake of Fruits and Vegetables, High-Fat Foods, and Sugar-Sweetened Beverages During Past 24 h, Overall and for Purchases From Fast-Food Restaurants, Among Mothers, by Level of SNAP-Ed Intervention Reach, California, 2014

<table>
<thead>
<tr>
<th>Dietary Behavior</th>
<th>Unadjusted Mean (Constant)</th>
<th>Adjusted Mean (Constant)</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
<th>Moderate β (SE)</th>
<th>High β (SE)</th>
<th>Moderate vs No/Low (P)</th>
<th>High vs No/Low (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall intake</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruits and vegetables, cups</td>
<td>3.04</td>
<td>2.76</td>
<td>−0.164 (0.112)</td>
<td>0.034 (0.113)</td>
<td>.14</td>
<td>&lt; .01</td>
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<tr>
<td>High-fat foods, cal</td>
<td>100.2</td>
<td>101.7</td>
<td>−16.1 (13.4)</td>
<td>−34.6 (13.6)</td>
<td>.23</td>
<td>.01</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar-sweetened beverages, cups</td>
<td>1.18</td>
<td>1.43</td>
<td>0.094 (0.086)</td>
<td>−0.171 (0.086)</td>
<td>.27</td>
<td>.05</td>
<td></td>
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</tbody>
</table>

Intake from items purchased from fast-food restaurants

<table>
<thead>
<tr>
<th>Dietary Behavior</th>
<th>Unadjusted Mean (Constant)</th>
<th>Adjusted Mean (Constant)</th>
<th>Unadjusted Mean</th>
<th>Adjusted Mean</th>
<th>Moderate β (SE)</th>
<th>High β (SE)</th>
<th>Moderate vs No/Low (P)</th>
<th>High vs No/Low (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fruits and vegetables, cups</td>
<td>0.091</td>
<td>0.093</td>
<td>0.006 (0.015)</td>
<td>0.030 (0.015)</td>
<td>.67</td>
<td>.05</td>
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<tr>
<td>High-fat foods, cal</td>
<td>30.8</td>
<td>31.9</td>
<td>−6.96 (6.09)</td>
<td>−13.3 (6.15)</td>
<td>.25</td>
<td>.03</td>
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</tr>
<tr>
<td>Sugar-sweetened beverages, cups</td>
<td>0.122</td>
<td>0.161</td>
<td>0.017 (0.025)</td>
<td>−0.036 (0.026)</td>
<td>.49</td>
<td>.16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy Eating Index–2010</td>
<td>54.1</td>
<td>50.6</td>
<td>−1.23 (0.692)</td>
<td>1.28 (0.700)</td>
<td>.08</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SNAP-Ed indicates Supplemental Nutrition Assistance Program–Education.

Note: SNAP-Ed Intervention Reach represents the number of SNAP-Ed recipients divided by the SNAP-Ed eligible population per census tract: no/low, 0 to ≤ 0.10; moderate, > 0.10 to ≤ 0.25; high, > 0.25 to 1.0. Outcome variables by levels of SNAP-Ed intervention reach were tested using linear regression with race/ethnicity and education as covariates.
products or empty-calorie refined grain
snacks, side dishes, or dessert items. As
such, SNAP-Ed may be effective in
altering consumption of certain types
of foods and beverages, but not as a
means of changing overall diet quality.
Strengths of this study include a
representative sample of mothers from
California SNAP households. In addi-
tion, the 4 outcomes measures were
derived from detailed dietary informa-
tion from a 24-hour multiple-pass inter-
view methodology that provided increased
measurement sensitivity compared with
that available from previous studies
using food-frequency questionnaires.
Number of cups of fruits and vegeta-
tables, for example, were based on the
sum of cups of 100% fruit juice and
identified portion sizes for each type
of fruit and/or vegetable consumed at
each meal or snack. These data were
obtained by interviewers who received
extensive training on the ASA24,
which included assisting survey re-
spondents in identifying applicable
portion sizes by probes and by refer-
ning them to measuring cups and
spoons and pictures in a portion-size
booklet that had been previously sent
to respondents. The quality of these
data allow for improved precision to
detect real differences across groups
compared with traditional food-
frequency questionnaires. Finally, the
majority of the sample was mothers
from minority groups, and statistical
models allow for generalizing the find-
ings to low-income mothers regardless
of racial/ethnic background.
A limitation of the study includes
the absence of physical activity to
investigate caloric balance in relation
to levels of SNAP-Ed interventions.
Another major limitation is a presumed
rather than verified level of exposure to
SNAP-Ed. An ecological study repre-
sents the best approach to an evalua-
tion of SNAP-Ed at the population
level but leaves unanswered questions
such as which types and levels of direct
education interventions are most effec-
tive. This study did not include and
thereby cannot rule out the effects of
other individual or community factors
that could explain more healthful
eating among mothers from high-
reach census tracts, including other in-
terventions or campaigns aimed at the
SNAP-eligible population. Final, nonre-
sponse bias should be considered when
interpreting the results.

IMPLICATIONS FOR
RESEARCH AND
PRACTICE
In contrast to the ecological research
design used in the current study,
SNAP-Ed interventions are guided by
the Social-Ecological Model,2 which
recognizes that multiple sectors of so-
ciety beyond individuals, including
environmental factors, influence
eating behaviors as well as physical ac-
tivity. The USDA’s support for policy,
systems, and environmental (PSE) ap-
proaches beginning in FFY 2013 have
since allowed California and other
states to place greater emphasis on
environmental factors, including
those in indoor (schools and retail
sites) and outdoor (farmers’ markets
settings, as well as to support the
development of wellness policies.
Starting in FFY 2017, California
LHDs are required to pair all tradi-
tional nutrition education strategies
directed at individuals, families, or
groups with PSE interventions to
maximize the potential for positive
behavior change. Thus, future studies
should test whether such new or
enhanced interventions are related
to dietary quality outcomes.
This correlational study provides
evidence that SNAP-Ed is effective at
what it has been designed to do: in-
crease fruit and vegetable consump-
tion and decrease intake of high-fat
foods and sugar-sweetened beverages
among low-income populations.
However, the totality of these changes
appears to be insufficient to affect diet
quality. Perhaps the increased diffu-
sion of PSE interventions in the US,
and specifically when combined with
direct education as required in Cali-
ifornia beginning in FFY 2017, will be
more effective than interventions im-
plemented in California in 2014 at
improving overall diet quality. By
including an assessment of levels of
physical activity, future studies may
also find links between SNAP-Ed and
caloric balance.

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CONFLICT OF INTEREST

The authors have not stated any conflicts of interest.