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Dietary Quality of Americans by Supplemental Nutrition Assistance Program Participation Status A Systematic Review

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Abstract

Context—The Supplemental Nutrition Assistance Program (SNAP) is an effective component in reducing food insecurity in the U.S. In the discussion of strategies to also help SNAP participants maximize diet quality, it is important to know their current dietary patterns and food choices. This paper provides a systematic review of recent U.S. studies on dietary quality, food consumption, and spending among SNAP participants as compared to income-eligible and higher-income nonparticipants.

Evidence acquisition—The review, completed in 2014, summarized studies that were peer-reviewed, published between January 2003 and August 2014, and provided data on dietary quality and intake of SNAP participants and nonparticipants.

Evidence synthesis—Twenty-five studies were included in this review. Daily caloric, macronutrient, and micronutrient intake of SNAP participants did not differ systematically from those of income-eligible nonparticipants; however, differences in dietary quality emerged. Adult SNAP participants scored lower on the Healthy Eating Index than either group of nonparticipants. Children's diets were similar among SNAP participants and low-income nonparticipants, but were less nutritious than diets of higher-income children. The evidence regarding sugar-sweetened beverage consumption was mixed, with most studies indicating significantly higher beverage intake among SNAP participants compared with higher-income nonparticipants, but no difference compared to income-eligible nonparticipants.

Conclusions—SNAP effectively alleviates food insecurity in terms of caloric, macronutrient, and micronutrient intake. Still, SNAP participants are struggling more than income-eligible and higher-income nonparticipants to meet key dietary guidelines. Future policies should ensure that this vital food assistance program addresses diet quality while reducing food insecurity.

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Context

The Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program, is the largest federal food assistance program that serves as a safety net against food insecurity and provides income support to alleviate poverty.¹ In fiscal year (FY) 2014, SNAP served approximately 46.5 million people, about one in seven Americans.² Almost half (45%) of SNAP participants were children under age 18 years and about 9% were aged 60 years or older.³ The total investment in SNAP exceeded \$73.7 billion in FY2014, providing on average \$125 in monthly food benefits per participant.²

Prior research has shown that SNAP meets the goal of reducing hunger and food insecurity among SNAP participants.^{4–6} The program's impact on dietary quality and intake is less clear. The previous systematic review of SNAP outcomes conducted by the U.S. Department of Agriculture (USDA) in 2004 found little to no impact on dietary intake, including food energy and macronutrients.⁷ The effect of SNAP on food consumption varied by food type, but SNAP participants were significantly less likely to meet Dietary Guidelines recommendations.⁷ For example, SNAP participation was found to increase consumption of meats, added sugars, and total fats, but had no effect on participants' intake of fruits, vegetables, grains, or dairy products.⁷ Further evidence suggested that compared with income-eligible nonparticipants, SNAP participants were more likely to have nutritionally poor diets.^{8,9}

Assessing the impact of SNAP on food insecurity and dietary quality is challenging, owing to several methodologic issues. Particularly important here is selection bias in that households in most need of food assistance and diet improvement are also more likely to participate in SNAP. Controlling for income does not resolve the issue; with the sliding-scale nature of SNAP benefits, many SNAP participants are at the lower end of income eligibility compared with income-eligible nonparticipants. As a result, baseline differences in food insecurity among participants and nonparticipants are so large that they could mask the beneficial effect of SNAP participation.⁶ Studying the impact of SNAP is further limited by the frequent use of survey data in which SNAP participation is misreported by as many as 19%–25% of respondents.¹⁰ In addition, SNAP participation is often a dichotomous measure when SNAP benefits are variable amounts. Given benefit variation, program outcomes could vary too. Finally, an experimental design to test the effect of SNAP among randomly selected participants is impossible based on ethical grounds.

In recent years, the quality of diets among SNAP participants has emerged as a public policy concern, given the increasing prevalence of diet-related chronic illnesses among all Americans, particularly in low-income populations. The current USDA approach to promoting nutrition among SNAP participants is nutrition education (SNAP-Ed) in accordance with the Healthy, Hunger-Free Kids Act of 2010. Authorized at \$407 million nationally (FY2015), SNAP-Ed provides federal grants to states for nutrition education and obesity prevention programs. The program aims to use evidence-based activities that promote healthy food choices within a limited budget.¹¹ Impact studies are underway to assess the effectiveness of SNAP-Ed initiatives.¹²

A wide range of additional policies has been proposed to improve dietary quality among SNAP participants. Many proposals focus on incentivizing purchases of healthy foods.¹³ The effect of providing financial incentives to SNAP participants at the point of sale was recently evaluated in an RCT. Known as the Healthy Incentive Pilot, the study showed that a 30% subsidy of targeted fruit and vegetable purchases increased their consumption by SNAP participants by 26%.¹⁴ There are also incentive programs, known as Double Bucks, that provide a match to SNAP benefits for fruit and vegetable purchases at farmers markets.¹⁵ Increased funding and evaluation of these programs are expected through the Food Insecurity and Nutrition Incentive grant program authorized in the Agricultural Act of 2014. Food Insecurity and Nutrition Incentive grants will provide \$100 million over 5 years to support projects that increase purchases of fruits and vegetables among SNAP participants by providing incentives at the point of purchase.¹⁶

In contrast to the incentive approaches, some proposals suggest restrictions on allowable foods for purchase with SNAP benefits, such as disallowing the use of SNAP funds to purchase sugar-sweetened beverages (SSBs) or foods of minimal nutritional value. Other proposals include a general benefit increase and new approaches based on behavioral economics. In fall 2014, USDA established a new research center to test ideas based on behavioral economics on how to improve healthy food purchases among participants in food assistance programs.¹⁷

To inform the ongoing discussion about SNAP, this paper provides a systematic review of recent U.S. studies on the quality of diets among Americans by SNAP participation status. Specifically, it describes the current evidence on dietary quality, food consumption, and spending among SNAP participants as compared to income-eligible and higher-income nonparticipants, and considers to what extent the program might have a positive or negative association with dietary quality and intake. Comparisons to nonparticipants provide a reference for better interpretation of findings and more policy-relevant analysis. Meeting the dietary recommendations is a goal for all Americans, but expectation setting for SNAP participants should consider the feasibility of meeting these goals among people with similar and higher incomes. The paper updates results from another literature review that examined data on dietary outcomes of SNAP participation published between 1973 and 2002.⁷

Evidence Acquisition

Studies were identified by searching electronic databases (PubMed and EconLit), examining research publications from the USDA Economic Research Service and the Food Nutrition Service, and reviewing bibliographies of the extracted studies. Searches were completed using the key words *SNAP OR food stamp* with each of these terms: *diet, dietary adequacy, dietary effects, dietary impacts, dietary intake, dietary outcomes, dietary quality, dietary patterns, dietary practices, dietary trends, dietary variety, food choices, food intake, food consumption, food selections, food use, Healthy Eating Index, eating behaviors, eating practices, nutrient intake, nutrient content, nutritional adequacy, sugar-sweetened, fruits and vegetables, vegetables, fruits, whole grains, soda, food, and nutrition*. Most of these search terms were used in the previous review on the topic.⁷

The inclusion criteria for this review were that the paper:

1. was a peer-reviewed study;
2. used U.S. data;
3. provided original data on the association between SNAP participation and dietary outcomes, including dietary quality, food and nutrient intake, and food spending;
4. was published in English;
5. was published between January 2003 and August 2014;
6. provided a comparison group for SNAP participants with data for either income-eligible or higher-income nonparticipants or both; and
7. did not contain food insecurity or obesity as the only outcomes.

Studies published prior to January 2003 were reviewed elsewhere.⁷ Reviews on SNAP participation and obesity¹⁸ or food insecurity¹⁹ are also available. Finally, income eligibility was defined broadly as low income; some studies used a standard income cutoff for SNAP eligibility of 130% of the federal poverty line, whereas others applied a wider 200%—300% threshold. The search was completed in August 2014.

Evidence Synthesis

The search yielded a total of 780 unique titles (Figure 1). Initial screening was based on titles, after which 131 abstracts were reviewed and 49 full-text manuscripts were retrieved. Reference lists of these manuscripts were screened to identify any studies missed during the initial search. The full-text papers were reviewed independently by two study authors. Examples of studies that did not meet all inclusion criteria were surveys of SNAP participants with no comparison group. The final screening revealed 25 studies that met all inclusion criteria (Table 1). These studies were grouped into five (not mutually exclusive) outcome categories: diet scores, food energy and intake, macronutrients, vitamins and micronutrients, and food spending and meal patterns. The last two outcomes, although not strictly measures of dietary quality or intake, are presented as additional factors to offer insights into dietary quality. When available, the results were extracted separately for children, adults, and the elderly.

There was substantial variation in their data scope, from fairly small, convenience samples (which were weighted less heavily in our synthesis and discussion) to large, national samples (which were weighted more heavily as more reliable and generalizable). The majority of the papers ($n=19$),^{7,21–24,26,28,30,31,33–40,42,43} reported results of analyses based on nationally representative data sets, including the National Health and Nutrition Examination Survey ($n=10$),^{7,21,23,26,28,30,31,34,39,40} Consumer Expenditure Survey ($n=5$),^{22,33,34,35,38} Continuing Survey of Food Intake for Individuals ($n=2$),^{36,43} Current Population Survey ($n=2$),^{37,42} and Early Childhood Longitudinal Survey ($n=1$).²⁴ A large, representative but local data set was used in one paper.²⁹ Convenience samples were used in the remaining five papers.^{20,25,27,32,41} Fifteen studies included data on adults,

7,21,23,25–30,32,34,39–42 six studies reported data on children,^{7,23,24,31,36,43} and six studies provided data at a household level.^{20,22,33,35,37,38}

With the exception of three papers, studies attempted to adjust for the observed variation by including sociodemographic covariates. Only three studies^{26,39,43} attempted to demonstrate causality of SNAP's impact on diet. Using an instrumental variable approach^{26,39} or maximum likelihood estimator⁴³ to account for unobserved relationships in the data, the authors used the most methodologically rigorous designs and likely produced the most reliable estimates of the impact of SNAP participation on dietary quality and intake.

Figures 2–4 summarize the results. Outcomes examined based on one study are not reported, but are available upon request.

Supplemental Nutrition Assistance Program-Participating Adults and Low-Income Nonparticipants

Sixteen studies examined associations between SNAP participation and dietary quality and intake in income-eligible U.S. adults. Most of the studies^{7,21,23,26,28,30,37,39,42} were based on national age-diverse samples, five studies were based on convenience samples,^{25,27,32,41,44} one study was a national age-specific sample,⁴⁰ and one was a locally representative sample.²⁹ Three studies reported data separately for elderly adults.^{7,23,25} The findings varied by outcome, with most results suggesting no statistically significant difference in the dietary outcomes of SNAP-participating adults and income-eligible non-participants (Figure 2).

Consistent Findings Across Studies

Several findings were consistent across all relevant studies. There was no difference in consumption of meat, milk and milk products, fats and oils, or sweets and desserts among SNAP and income-eligible nonparticipating adults. Average intake of all macronutrients but fiber was also the same for the two groups. No difference was reported for vitamin A, vitamin B12, vitamin C, and sodium. Only two outcomes, zinc intake and spending on food away from home (FAFH), were significantly lower among SNAP-participating adults versus income-eligible nonparticipants. SNAP participation was related to higher total food spending, higher spending on food for home consumption, and lower FAFH spending as compared with low-income nonparticipants.^{35,37,42}

Mixed Findings Across Studies

The primary discrepancies in findings for low-income adults were for energy intake, consumption of grains, fruits, vegetables, SSB consumption, and diet scores. Although most studies on energy intake (calories), including national assessments, showed no difference between SNAP participants and income-eligible nonparticipants,^{25,30–32} there was important variation in the results by gender and age. One study found that SNAP-participating women aged 19–30 years consumed more calories than nonparticipants (95% of the 1989 Recommended Energy Allowance vs 91%, $p < 0.01$), but among women aged 31–50 years, the difference was reversed.⁷ Among men, the average age-adjusted food energy intake of SNAP participants was significantly greater than that among income-eligible nonparticipants (108% vs 95%, $p < 0.001$).⁷

Most studies reported no difference in fruit and vegetable consumption between the two groups.^{25,27,30–32} A methodologically sound assessment of the nationally representative data concluded that SNAP participation increases whole fruit consumption.²⁶ Whole-grain intake was lower in SNAP participants compared with income-eligible nonparticipants,^{27,30} even though total grain consumption was mostly the same.^{23,25,31} One study showed higher intake of refined grains among SNAP-participating adults.³²

Ten studies examined SSB consumption of SNAP adult participants. Four found significantly higher consumption among SNAP participants as compared with income-eligible nonparticipants,^{20,29,30,41} whereas the other six studies^{7,21,23,39,27,32} did not report any difference. Among the studies showing a difference, two had significant results for women only,^{30,41} and two studies reported regional data (New England and California).^{20,29} None of the studies finding higher SSB consumption among SNAP participants were based on national samples or used research designs to demonstrate causality.

For nutrients, minerals, and vitamins, some discrepancies emerged for calcium, iron, and fiber. Specifically, a convenience sample of black women on SNAP⁴⁰ had higher calcium intake, but lower intake was reported among those aged 19–30 years,⁷ and no difference in several other studies, including two national assessments.^{23,30} Fiber was similar across most studies, but lower for SNAP participants aged 19–31 years and 51–70 years in one national study.⁷ The same was true for findings on iron intake, which was similar across the two groups, except for one national study.⁷ Finally, although SNAP-participating adults were as likely as income-eligible nonparticipants to consume three meals per day, this was not always true for the elderly.^{7,23}

Results based on dietary scores, such as the Healthy Eating Index (HEI), show that diets of all population groups fail to meet the dietary recommendations. For example, the average HEI-2005 score was 58 out of a maximum 100.²³ SNAP-participating adults had significantly lower HEI-2005 scores than income-eligible nonparticipants in two national studies (51 vs 57, $p < 0.05$ and 47 vs 51, $p < 0.01$, respectively) and one age-specific sample,⁷ but not in the assessment based on the 1999–2008 National Health and Nutrition Examination Survey.³⁰ No significant differences in HEI scores were reported for the elderly and adults aged 31–50 years.^{7,23} Another measure of dietary quality, a modified Alternative HEI,⁴⁴ showed no difference by SNAP among low-income adults in a longitudinal analysis of a convenience sample in Massachusetts,³² but a significantly lower dietary quality among SNAP adult participants in a national sample.³⁰

The analysis of the HEI components (Appendix 2, available online) showed mostly similar dietary quality among low-income adults irrespective of SNAP, with several important exceptions. Lower consumption of whole fruit was reported in two national studies.^{23,26} Mixed results were reported for whole grains, total grains, milk, meats, and calories from solid fats, alcoholic beverages and added sugars,^{23,26,30} with more national studies suggesting no difference by SNAP status.

Supplemental Nutrition Assistance Program—Participating Children and Low-Income Nonparticipants

There were relatively few studies with data on children (Figure 3), which might explain the lack of variation in the results. Specifically, no significant difference by SNAP was shown for the majority of outcomes in low-income children, including indicators such as HEI, energy intake, fruit and vegetable consumption, macronutrient intake, and probability of consuming three meals per day.^{7,23,31} Several discrepancies emerged across studies, with some suggesting better dietary outcomes in SNAP-participating children (higher whole-grain consumption and folate, calcium, iron, and zinc intake).³¹ There were also discrepancies in less favorable outcomes, such as higher SSB consumption, increased intake of high-fat dairy, and lower fiber and vitamin C intake among SNAP children versus low-income nonparticipants.^{7,31,43}

Supplemental Nutrition Assistance Program Adult Participants and Higher-Income Nonparticipants

Compared with higher-income nonparticipants, adults on SNAP fare significantly poorer on the majority of dietary measures (Figure 4). For example, HEI scores were significantly lower, except for the elderly.^{7,23} The reviewed studies did not include Alternative HEI assessment of dietary quality in higher-income nonparticipants. There were mixed findings on SSB consumption among SNAP adults and higher-income nonparticipants, but the two most recent national studies suggest higher SSB intake among SNAP participants.^{7,21,23}

SNAP participants had lower intake of many important vitamins and nutrients, including vitamin C, calcium, fiber, and iron.^{7,23} Sodium intake was also lower among SNAP-participating adults compared with higher-income nonparticipants.^{7,23} Relative to higher-income nonparticipants, there was no difference in FAFH consumption among all households, but households with children had lower FAFH intake,³³ and SNAP households spent less on FAFH.³⁵ Studies of spending behaviors found that SNAP households prioritized purchases of beef and frozen foods over other foods.³⁸ Relatively low spending on fruit and vegetables was reported,²² and an increase in income was not expected to significantly increase fruit and vegetable spending of SNAP participants.³⁸ Adults on SNAP were less likely to consume three meals per day than higher-income nonparticipants.^{7,23}

Supplemental Nutrition Assistance Program-Participating Children and Higher-Income Nonparticipants

Only two studies compared SNAP children and higher-income nonparticipants.^{7,23} Mixed results were found across outcomes and age groups (Figure 4). Compared with higher-income children, SNAP-participating children reported lower HEI scores, lower intake of vitamin C, calcium, and iron, higher intake of SSBs and sodium, and lower likelihood of consuming three meals per day. One study reported these effects only among young children (aged <5 years).⁷ Children aged 4–8 years on SNAP were more likely to meet adequate intake levels of zinc, and had higher mean intake of fiber.⁷ There were no significant differences in consumption of milk.^{7,23}

Discussion

The findings in this paper suggest that SNAP participants are generally able to obtain sufficient calories to sustain themselves. SNAP participants do not appear to consume too many or too few calories; their caloric intake does not systematically differ from that of income-eligible or higher-income nonparticipants. In the majority of the reviewed studies, including research based on rigorous designs and national samples, SNAP participants have either similarly low or significantly lower dietary quality than the comparison groups. Differences emerge when examining the types of foods in the diets across the three groups. Overall, dietary quality of SNAP-participating adults appears to be lower, especially as compared with higher-income nonparticipants. Adult SNAP participants' HEI scores are significantly lower than either group of nonparticipants. Diets of children on SNAP are no different from those of low-income nonparticipants, but are of lower nutritional quality than diets of higher-income children, particularly in the youngest group. One explanation for this finding is that SNAP participants use the most financially efficient method to obtain calories, which is purchasing inexpensive, yet nutrient-poor food products. Although there is debate as to whether it is more expensive to eat a healthy diet,^{45–47} having limited resources for food purchases appears to predict lower dietary quality. Consumption of higher energy—dense foods by SNAP participants might also explain why, despite eating fewer meals per day, energy intake of SNAP participants is no different than that of nonparticipants.

Children and adults on SNAP are less likely than higher-income nonparticipants to eat three meals a day. Skipping meals is a hallmark of food insecurity, and ensuring access to three meals a day is an important dietary outcome. Prior research suggests that children may be shielded by adults from food shortages and the negative effects of food insecurity.⁴⁸ Further, low-income children can participate in the National School Lunch Program (NSLP) and the School Breakfast Program, which help children get enough calories. For example, NSLP participation was found to reduce food insecurity by at least 1.4 percentage points, poor health by 3.1 percentage points, and obesity by 3.2 percentage points.⁴⁹ Notably, SNAP participants aged 4–18 years did not exhibit lower dietary quality than their higher-income nonparticipating peers.⁷ This suggests that participation in the federal school meal programs positively contributes to diets of low-income children.

Limitations

This review is subject to limitations of the reviewed studies and of the data synthesis. Owing to the variety of outcomes in this literature, we found it impossible to develop one quantitative metric to summarize and rank all findings. The variability and inconsistency in study design, included samples, and reported measurements would result in subjective findings. Therefore, we were precluded from conducting a meta-analysis or employing a quantitative assessment weighing studies by design. It is important to note that the reported differences represent statistically significant differences, but the magnitude of the differences across dietary measures may be modest.

The main limitation of prior research is that most studies did not attempt to establish causality in describing the diets of SNAP participants. Because of selection bias inherent in SNAP participation, it is possible that participants suffer more acutely from food insecurity

than low-income individuals who do not choose to participate. Lower-quality diets among SNAP participants could be due to the same conditions that led them to seek out SNAP benefits. Weak designs of many studies in this review make it difficult to draw policy conclusions. Further, in interpreting conflicting results across studies, it is important to note different measurement and data approaches. For the SSB analysis in particular, the general food frequency questionnaires²⁴ and studies with small samples^{27,32} were less likely to detect group differences than studies using 24-hour recall^{21,23,30} or purchase logs.²⁰ Future research should employ methods capable of capturing subtle differences in food consumption, such as more-robust sources of data or methodologies for capturing dietary intake, including purchase data and over sampling of SNAP-participating households in national surveys. For example, the newly released National Household Food Acquisition and Purchase Study (FoodAPS) provides detailed data on food purchasing behavior of SNAP participants and nonparticipants.

Many of the reviewed national studies were conducted in the late 1990s and early 2000s. There have been substantial changes to SNAP and other nutrition assistance programs (e.g., NSLP, Special Supplemental Nutrition Program for Women, Infants, and Children) since that time. During the Great Recession of 2007—2009, the amount of SNAP benefits increased, eligibility rules changed, and the program reached record numbers of Americans in need. Future studies should assess if and how the diets of SNAP participants changed in recent years. It is possible that findings from earlier studies would not be replicated for current SNAP participants who might show fewer differences compared with nonparticipants.

Additional research on dietary outcomes of children would be particularly beneficial. Although this review suggested fewer unfavorable findings for children versus adults on SNAP, this might be a reflection of limited data. In addition, low-income children who participate in SNAP may also utilize other food assistance programs, most notably the school meal programs. SNAP households may also participate in multiple nutrition assistance programs, such as Special Supplemental Nutrition Program for Women, Infants, and Children or Emergency Food programs. These findings may reflect the dietary effects of multiple programs, not just SNAP. Future research should distinguish the relative contribution of each federal food assistance program on household and individual diets, and specific impact on targeted subpopulations, such as elderly or pregnant women. Another important direction for future research on SNAP and dietary quality is to replace a dichotomous measure of SNAP participation with a more nuanced metric based on the benefit amount and length of participation. FoodAPS is relevant here, as it provides detailed data on SNAP benefit levels and dietary outcomes.

A number of strategies have been proposed, and some initially tested, to improve the diets of SNAP participants.^{13,50} There is still debate as to the most effective and efficient approach. For example, targeted nutrition education would not be intrusive and could potentially improve diets, but it could be costly and administratively burdensome, vary in design and delivery, and be difficult to measure. On the other hand, targeted incentives for healthy foods (e.g., Healthy Incentive Pilot, Double Bucks) could be effective at increasing purchases and nonpunitive, but costly and administratively complex. Increasing SNAP benefits is another

idea, although prior research suggests that substantial increases in food spending and SNAP benefit levels would be required to notably improve the diets of SNAP participants. For example, a 10% increase in food spending among SNAP households was estimated to increase HEI-2005 scores only by 0.33% and nutrient density by 0.46%, while reducing energy density by 0.57%.³⁴ Finally, limiting purchases of certain foods using SNAP benefits would be fairly inexpensive, yet the effect on total diet (not just targeted foods) is unknown, and increased stigma and reduced participation rates might follow. Support for the proposed approaches tends to be divided based on desire for expanding SNAP, beliefs about an acceptable level of paternalism or potential stigma, the costs, and the potential effectiveness of proposals. Political feasibility of each proposed approach is not static; the economy, political control of government, presence of stakeholders, and public support can sway considerably.

Conclusions

There is evidence that SNAP participants obtain adequate calories, but have lower dietary quality compared with nonparticipants. Household food choices are constantly evolving, a function of the food landscape and program policy design. As a result, there is a continuing need for program evaluation and outcomes research, particularly for subpopulations such as children. Potential strategies to improve nutrition among SNAP participants should receive careful consideration, weighing the costs and benefits of policy approaches.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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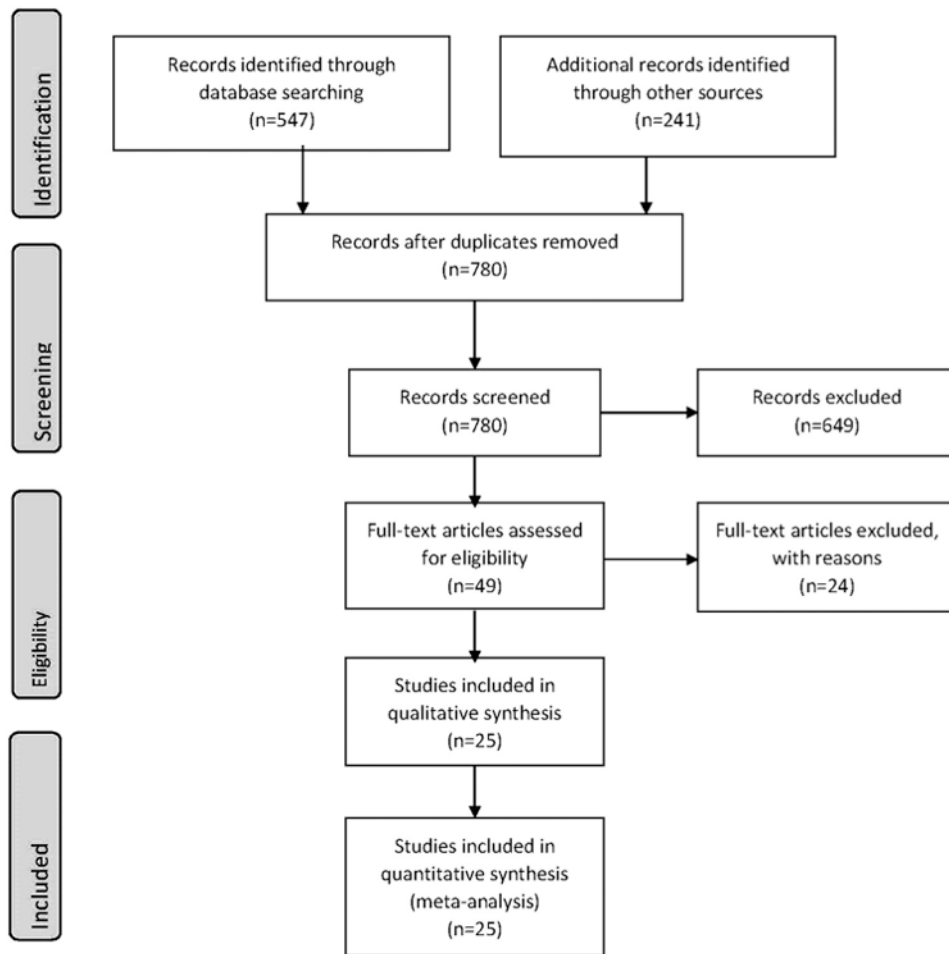


Figure 1. PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2009 flow diagram.

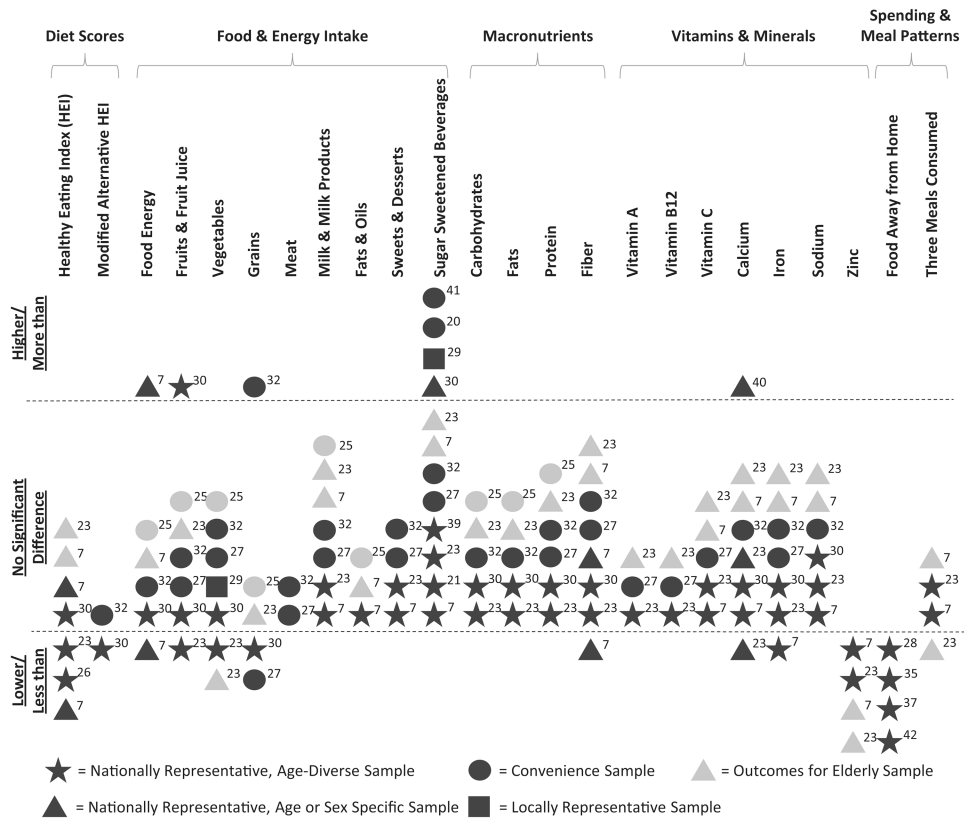


Figure 2. Differences in diet and nutrition among adults on the Supplemental Nutrition Assistance Program and low-income nonparticipants.
 Note: Numbers represent reference citations.

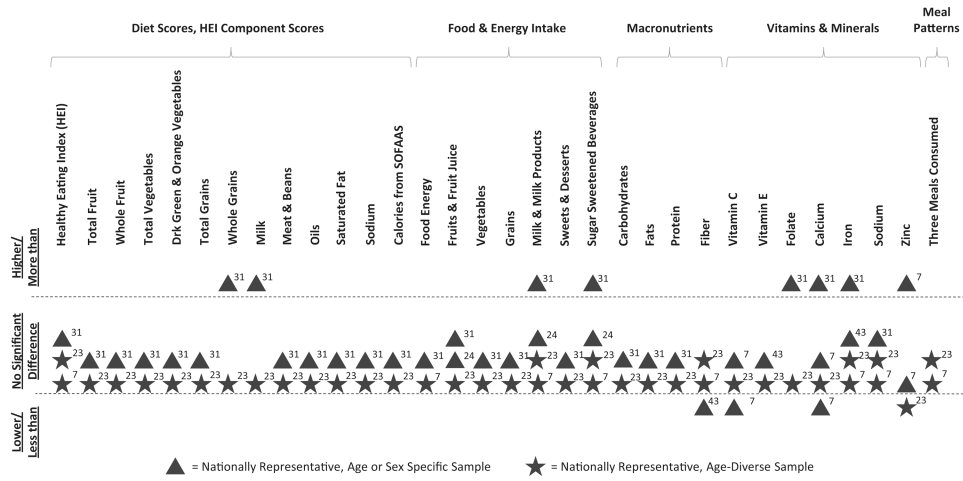


Figure 3. Differences in diet and nutrition among children on the Supplemental Nutrition Assistance Program and low-income nonparticipants.
Note: Numbers represent reference citations.
 HEI, Healthy Eating Index; SOFAAS, solid fats, alcoholic beverages and added sugars.

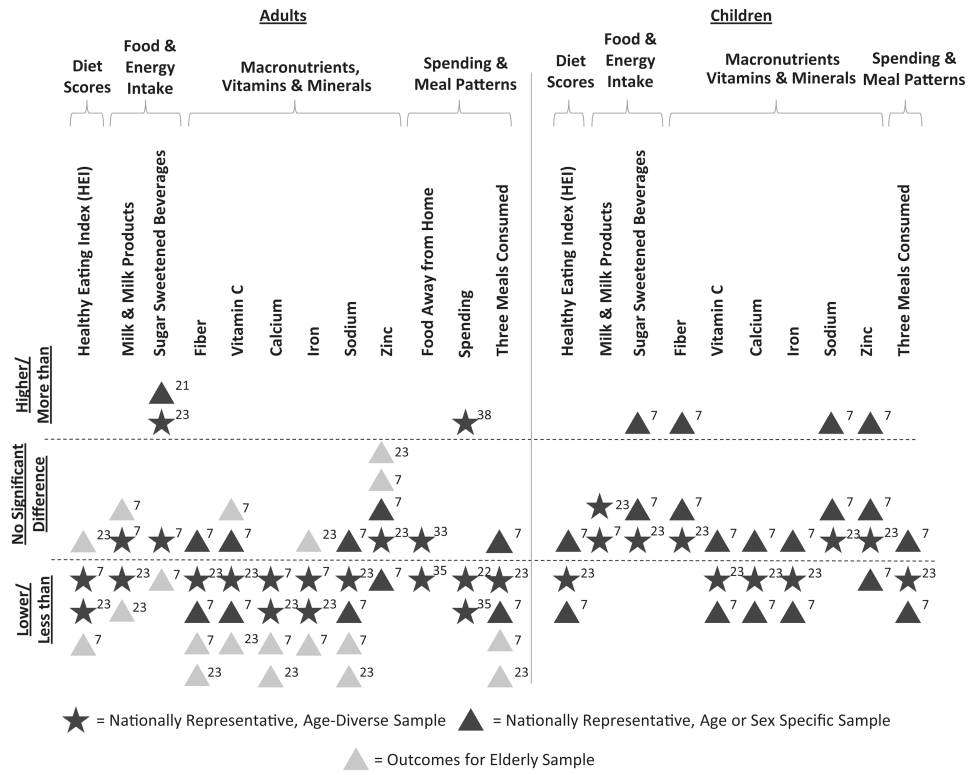


Figure 4. Differences in diet and nutrition among adults and children on the Supplemental Nutrition Assistance Program and higher-income nonparticipants. *Note:* Numbers represent reference citations.

Table 1

Summary of Sample

Author	n	Sample	Ages/strata	Low-income sample	Adjust for covariates	Causality
Andreyeva (2012) ²⁰	39,172	C	Households, young children	X		
Bleich (2013) ²¹	17,198	N	20 y+		X	
Blisard (2004) ²²	10,000	N	Households		X	
Cole (2008) ²³	25,170	N	All ages	X	X	
Fernandes, 2012 ²⁴	3,126	S	Kindergarten—7th grade		X	
Fey-Yensan (2003) ²⁵	200	C	60 y+	X	X	
Fox (2004) ⁷	29,004	N	All ages, substrata			
Gregory (2013) ²⁶	6,688	N	18 y+		X	X
Hilmers (2014) ²⁷	661	C	F, 26—44 y	X	X	
Jilcott (2011) ²⁸	945	N	20—65 y	X	X	
Leung (2011) ²⁹	7,741	L	18 y+	X	X	
Leung (2012) ³⁰	3,835	N	20—65 y	X	X	
Leung (2013) ³¹	5,193	S	4—19	X	X	
Leung (2014) ³²	107	C	18 y+	X	X	
Liu (2013) ³³	11,674	N	Households		X	
Mabli (2010) ^{34a}	2,584	N	Households, 18 y+	X	X	
Mabli (2013) ³⁵	210,000	N	Households	X	X	
Mendoza (2006) ^{36a}	11,284	N	19 y		X	
Pan (2008) ³⁷	12,071	N	Households	X	X	
Stewart (2008) ³⁸	5,275	N	Households		X	
Todd (2014) ³⁹	4,594	N	20 y+	X	X	X
Wang (2006) ⁴⁰	2,905	S	Postmenopausal women	X	X	
Watt (2013) ⁴¹	152	C	Pregnant women or with child <	1 y	X	
Wilde (2009) ⁴²	165,231	N	18 y+	X		
Yen (2010) ⁴³	1,446	S	2—5 y	X	X	X

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Note: Covariates commonly adjusted for among the selected studies include age, gender, marital status, race/ethnicity, BMI, income, health insurance status, household size, food security and participation in the Special Supplemental Nutrition Program for Women, Infants, and Children.

^aStudy is not included in Figures 2, 3, or 4.

C, convenience sample; L, local population, representative sample; N, nationally representative sample; S, representative sample for a defined age or gender.