Food Expenditures and Diet Quality Among Low-Income Households and Individuals

Final Report

July 2010

James Mabli
Laura Castner
James Ohls
Mary Kay Fox
Mary Kay Crepinsek
Elizabeth Condon

MATHEMATICA
Policy Research, Inc.

This page has been intentionally left blank for double-sided copying.

Contract Number:
AG-3198-D-07-0114

Mathematica Reference Number:
06408.600

Submitted to:
USDA, FNS
3101 Park Center Drive
Alexandria, VA 22302
Project Officer: Michael DePiro

Submitted by:
Mathematica Policy Research
600 Maryland Avenue, SW
Suite 550
Washington, DC 20024-2512
Telephone: (202) 484-9220
Facsimile: (202) 863-1763
Project Director: Laura Castner

Food Expenditures and Diet Quality Among Low-Income Households and Individuals

Final Report

July 2010

James Mabli
Laura Castner
James Ohls
Mary Kay Fox
Mary Kay Crepinsek
Elizabeth Condon

This page has been intentionally left blank for double-sided copying.

ACKNOWLEDGEMENTS

This report was prepared by James Mabli, Laura Castner, James Ohls, Mary Kay Fox, Mary Kay Crepinsek, and Elizabeth Condon of Mathematica Policy Research for the U.S. Department of Agriculture's Food and Nutrition Service (FNS), Office of Research and Analysis. Many individuals made important contributions to this report. The authors thank Phil Gleason for providing guidance and reviewing the report; Stephen Lipscomb for discussing analytical results; Daisy Ewell, Kerianne Hourihan, Xiaofan Sun, and Morris Hamilton for their programming expertise; and Jackie McGee and Lisa Walls for preparing the manuscript. The authors also thank Michael DePiro, Steven Carlson, Carol Olander, and Mark Lino of FNS and John Kirlin of the U.S. Department of Agriculture's Economic Research Service for their review and comments.

This page has been intentionally left blank for double-sided copying.

CONTENTS

CONTENTS (*continued*)

CONTENTS (*continued*)

CONTENTS (*continued*)

CONTENTS (*continued*)

This page has been intentionally left blank for double-sided copying.

TABLES

TABLES (*continued*)

FIGURES

FIGURES (*continued*)

FIGURES (*continued*)

FIGURES (*continued*)

FIGURES (*continued*)

This page has been intentionally left blank for double-sided copying.

EXECUTIVE SUMMARY

With more than 38 million monthly participants, the Supplemental Nutrition Assistance Program (SNAP)[1] is the largest of the nation's nutrition assistance programs, and the U.S. Department of Agriculture (USDA) Food and Nutrition Service (FNS) is responsible for assessing how well it is working. With a stated goal "to provide for improved levels of nutrition among low-income households" (Food and Nutrition Act 2008), an important measure of success is the extent to which SNAP participation improves nutritional intake.

Without random assignment, assessments of SNAP impacts are subject to important limitations. In particular, any associations between improved diet quality and SNAP participation may result from program effects or from the characteristics that led people to decide to participate. This problem, frequently called "selection bias," can be solved using experimental approaches. However, SNAP legislation does not allow withholding benefits from eligible persons, so experimental approaches, such as random assignment, would be challenging to implement.

Recognizing the difficulties inherent in determining the impact of SNAP on nutritional outcomes, in 2005 FNS convened a panel of experts to consider alternate approaches for studying program impacts (Burstein et al. 2005). Since SNAP is believed to work primarily through increasing food expenditures, a critical link in its success depends on whether greater food expenditures lead to greater nutritional quality in people's diets. The current study was carried out to address the question of whether there are associations between food expenditures and nutritional quality and is one of a set of related studies recommended by the panel. Within that context, the goal of this study is to identify whether spending more money on food leads SNAP participants and, more generally, other low-income households and individuals, to purchase and consume foods that are more nutritious.

Research Questions

The current study uses extant data to study food expenditures and dietary outcomes. In particular, the goal as defined by FNS is to:

- Describe and compare the relationship between food expenditures and food use patterns among households as mediated by a variety of factors, including participation in SNAP.

More specifically, we address the following research questions:

- Among low-income households and individuals, is an increase in food expenditures associated with an increase in nutritional quality of diets?
- What factors or household characteristics mediate these relationships?

[1] On October 1, 2008, the Food Stamp Program changed its name to the Supplemental Nutrition Assistance Program.

- Does the relationship between food expenditures and quality of the household food supply vary between SNAP households, other eligible households, and higher income households?

Thus, in this study, we seek to quantify the relationship between spending on food and the quality of individual and household diets. We discuss these relationships for SNAP participants and other low-income individuals and households, where we define low income as income under 300 percent of poverty. We also examine the relationships by race and ethnicity, age, and gender.

Measuring Nutrition, Diet Quality

There is no single, generally accepted measure of nutritional quality. Recognizing this, we evaluate nutritional quality using six distinct measures. The measures that we chose allow us to assess various aspects of diet quality—there are measures that examine foods as well as nutrients and ones that differentiate between nutrients that are of public concern because of potential inadequate or excessive intakes. The six measures are:[2]

- Scores on the **Healthy Eating Index (HEI)-2005** dietary quality scale. The HEI-2005 measures food quality in relation to the most recent federal dietary guidelines in the MyPyramid food guidance system (USDA 2007) and provides a composite measure of overall diet quality, as well as measures of 12 components.
- **Nutrient availability/intake**, including essential vitamins and minerals, fiber, and other micronutrients, including ones that are at risk of underconsumption and ones that are of concern because of potential overconsumption. These measures are scaled to a per-1,000 calories-available basis.
- **Energy density**, measuring the calories provided per gram of food available.
- A measure of **nutrient density** called the Modified Naturally Nutrient Rich (NNR) score. This is a nutrients-to-calories ratio, identifying the concentration of 16 vitamins and minerals, fiber, and protein, relative to energy content.
- **Food shares**, capturing the availability of foods in the household by major food group, on the basis of cup or ounce equivalents per 1,000 calories available.
- **Share of food expenditures spent on food categories**, measuring the percentage of total food expenditures that has been allocated to foods recommended for frequent consumption, foods not recommended for frequent consumption, and other foods as well as individual food groups, such as fruits, vegetables, and grains.

[2] We also examine usual energy and nutrient intakes, assessing whether spending more on food per calorie consumed is associated with the nutritional adequacy of diets consumed by low-income individuals. Because of methodological constraints associated with this measure, the results are not directly comparable with the other measures of diet quality considered here. We discuss the constraints and results for this additional measure in Appendix B.

Similarly, no single data source is ideal for measuring nutritional quality, so we use three extant data sources:

- The **National Food Stamp Program Survey** (NFSPS), collected in 1996 by Mathematica Policy Research. It includes a seven-day diary of foods used by the household from the household food supply and the expenditures on those foods. The results from this data set are focused specifically on SNAP participants.
- The **National Health and Nutrition Examination Survey** (NHANES) for 2001-2002 and 2003-2004, originally developed by the National Center for Health Statistics and modified by USDA's Center for Nutrition Policy and Promotion (CNPP) with average prices for foods. It includes a 24-hour recall of foods consumed by individuals. We use this to identify patterns and associations for all low-income individuals, as well as by SNAP participation and eligibility status.
- The diary component of the **Consumer Expenditure Survey** (CE), collected in 2005 by the U.S. Census Bureau for the Bureau of Labor Statistics. It provides expenditures on food for various food categories. We use this data set to examine associations for the low-income population and by SNAP participation and eligibility status.

These three data sets are nationally representative sources that provide information about both individual foods, which are required to compute the diet quality measures, and food prices, which are required to identify differences in the measures by the amount spent on food. Although none of them is ideal for the analysis, they each have a specific strength. The seven-day diary of foods used in the NFSPS is preferred to the 24-hour recalls of NHANES, but the NHANES is more recent than the NFSPS and includes households at all income levels. The CE data also provides seven-day diaries, but the focus is on expenses rather than nutrients.

In Table 1, we provide a summary of the measures, categorizing them by the type of information they provide and the data sources used. For each data source, we use the food expenditures available within the dataset.

Table 1. Summary of Measures

	Type of Measure			Data Source		
	Composite/ Summary	Food Categories	Nutrients Provided	NFSPS	NHANES	CE–Diary
Measure of Nutritional Quality						
Healthy Eating Index–2005	✓			✓	✓	
Nutrient Availability/Intake			✓	✓	✓	
Energy Density	✓	✓		✓	✓	
Nutrient Density	✓	✓		✓	✓	
Food Shares		✓		✓	✓	
Expenditure Shares	✓	✓				✓

Relationships between Food Expenditures and Diet Quality

The primary means by which we measure the association between expenditures and diet quality is through regression models. In the models, the measure of diet quality, sometimes transformed by the natural logarithm, is the dependent variable, and the natural logarithm of food expenditures is the primary independent variable. We present results by providing either the percentage change or the absolute change, depending on specification of the model, in the diet quality measure that is associated with a 10 percent increase in food expenditures.[3]

For most measures we examine, an increase reflects the preferred outcome. For example, all components of the HEI-2005 are measured so that a higher score is better, and in most cases, higher intake of a vitamin or mineral is preferred. The exceptions are for energy density, in which lower energy-dense foods (fewer calories per gram) are preferred, as are lower levels of some minerals and macronutrients, such as sodium and saturated fat. We also examine spending on foods recommended and not recommended for frequent consumption. The desired outcome for spending would be an increase in spending on foods recommended for frequent consumption and a decrease in spending on foods not recommended for frequent consumption.

As presented in Figure 1, the sign of the association of each of the measures is in the direction of improved diet quality. That is, the HEI-2005 and nutrient density scores increase with expenditures, the energy density measure decreases, SNAP participants and low-income individuals spend a larger share of their food expenditures on foods recommended for frequent consumption, and low-income individuals spend a smaller share on foods not recommended for frequent consumption. As noted, the magnitudes of the association appear small, and would be even if they were presented in terms of the effect size (that is, in relation to the standard deviation). However, a larger increase in expenditures (say 20 or 30 percent) may lead to an increase in the magnitude of the association, although it may not be proportional.

The goal of this research is to determine how diet quality and food expenditures are related for SNAP participant households and, more generally, among low-income individuals. However, all findings must be interpreted with caution. To the extent that we find positive relationships for SNAP participants, the relationship is not necessarily causal, due to selection bias (factors that affect both expenditures and diet quality that are not accounted for in the model either because they are unobserved or are not available in the data).

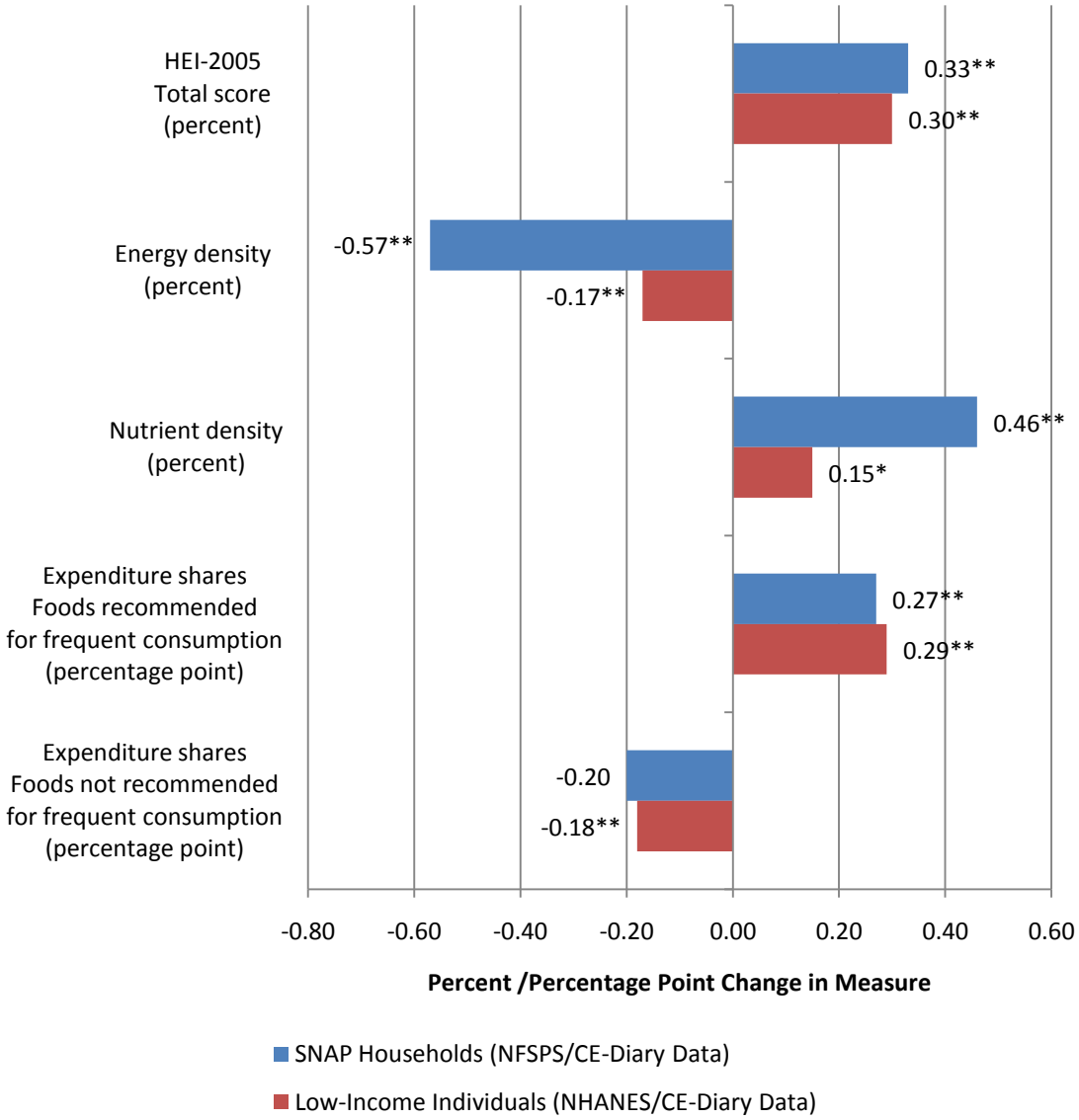
It is also important to recognize that a failure to find a relationship between food expenditures and the quality of household food supplies does not necessarily prove that SNAP is powerless to improve dietary intake. Burstein et al. (2005) identified several factors that may affect the ability of the analysis to detect an effect, including: (1) small sample sizes; (2) measurement error (associated with collecting the food use data and translating these data into nutrient equivalents); and (3) sampling variability associated with the small samples of data on foods withdrawn from household supplies. These data characteristics may obscure the relationship between food expenditures and diet quality.

[3] In figures and tables, we present both statistically significant and insignificant results. In the text, however, we discuss only the results that are statistically significant.

HEI-2005

A 10 percent increase in food expenditures (an increase of $5.91 per week based on mean expenditures) among SNAP households, as examined through the NFSPS, is associated with an increase in the HEI-2005 score of 0.33 percent, or from 52.31 to 52.48 (Figure 1). For the low-income population, using NHANES, a 10 percent increase in diet cost (an increase of $0.43 per day based on mean expenditures) is associated with an increase in the HEI-2005 score of 0.30 percent, or from 56.60 to 56.77.

Figure 1. Percentage/Percentage Point Change in Summary Measures Associated with 10 Percent Increase in Food Expenditures



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

The findings from both data sets indicate that the largest percentage increase in the component scores is for whole fruit. Scores for total fruit, total vegetables, and oils are also significantly higher for those spending more on food. For low-income individuals with higher diet costs, scores are lower for total grains, whole grains, saturated fat, and calories from solid fats, alcohol, and added sugars (SoFAAS) than for individuals with lower diet costs.

Nutrient Availability/Intake

Among SNAP participants examined through the NFSPS and low-income individuals examined through the NHANES, greater diet costs are associated with higher availability or intake of vitamins A, B_6, B_{12}, C, and E per 1,000 calories. Also for SNAP participants in NFSPS, greater spending on food is associated with higher availability of calcium, folate, iron, and potassium. From the NHANES, low-income individuals with higher diet costs consume greater amounts of niacin, magnesium, and potassium per 1,000 calories than do low-income individuals with lower diet costs. However, they also consume higher amounts of sodium and lower amounts of folate, riboflavin, thiamin, and iron per 1,000 calories.

The largest percentage increase is for Vitamin C, at 2.71 percent for SNAP participants and 2.87 for low-income individuals. Most of the other differences are less than 1 percent.

Energy Density

Energy density is the available food energy per unit weight, that is, calories per gram. Foods with high water content, such as fruits, vegetables, and milk, have low energy density, as do whole grains and cereals. Based on the NFSPS data, SNAP participants who spend more on food use foods from their home food supply that are slightly lower in energy density. That is, a 10 percent increase in spending on food is associated with a decrease in energy density of 0.57 percent. Among low-income individuals, as measured through NHANES, those with greater diet costs consume foods that are 0.17 percent lower in energy density.

Nutrient Density

SNAP participants, measured through the NFSPS, who spend 10 percent more on food score 0.46 percent higher on the nutrient-rich score. Low-income individuals with higher diet costs, measured through NHANES, scored 0.15 percent higher. For SNAP participants, most of the increase results from higher scores on two food groups: grains and grain products, and sweets, desserts, and salty snacks. For low-income individuals, the increase is driven largely by the scores for three food groups: total fruit; vegetables; and sweets, desserts, and salty snacks. The higher scores on specific food groups indicate that the foods consumed within those food groups by the individuals with higher costs were of higher nutrient density than the foods in the groups consumed by the individuals with lower costs.

Expenditure Shares

Low-income individuals spend 13.85 percent of their food expenditures on foods that can be identified in the CE-Diary data as recommended for frequent consumption. They spend about 38.51 percent on foods not recommended for frequent consumption, and almost half on foods that cannot be identified with information available in the data as to whether or not they are recommended for frequent consumption. Higher expenditures on food are associated with an

increase of 0.29 percentage points (to 14.14 percent) on foods recommended for frequent consumption, and a decrease of -0.18 percentage points (to 38.33 percent) on foods not recommended for frequent consumption.

Results by Food Categories

Most of the measures, with the exception of nutrient availability, can be examined separately by food categories.

Fruit

With the nutrition measures discussed above, higher food expenditures are associated with higher use and intake of fruits (Figure 2). For example, a 10 percent increase in food spending by SNAP participants is associated with a 1.96 percent increase in the HEI-2005 total fruit component score, increasing the fruit component of the HEI-2005 from 2.70 to 2.75 (out of a maximum of 5). The increase is even larger for whole fruits (excluding fruit juices), which have been one of the focal points for recent policy and public health discussions. A 10 percent increase in food expenditures is also associated with intake of fruits by low-income individuals that were 1.15 percent higher in nutrient density.

The food shares measure indicates the relative contribution of specific foods to MyPyramid groups and dietary components, such as sodium, saturated fat, discretionary fats and oils, and calories from SoFAAS. We first sum the weighted amounts of MyPyramid groups, for example cup equivalents in the fruit group, provided by a specific subgroup of foods, such as fruit juice; fresh, canned, dried, and frozen fruit; or baby food, for all households or individuals in the sample. We then divide by the total weighted amount of the MyPyramid group in the foods used by NFSPS households or consumed by all individuals in NHANES.

For the fruit MyPyramid group, we find that a 10 percent increase in spending on food is associated with a 0.78 percentage point increase in the relative contribution of fruit (fresh, canned, dried, or frozen) to the MyPyramid Fruit Group for SNAP participants and a 0.68 percentage point increase for low-income individuals. Expenditures on fruit, as a percentage of total food expenditures identified in the CE-Diary data, are also positively associated with spending on food.

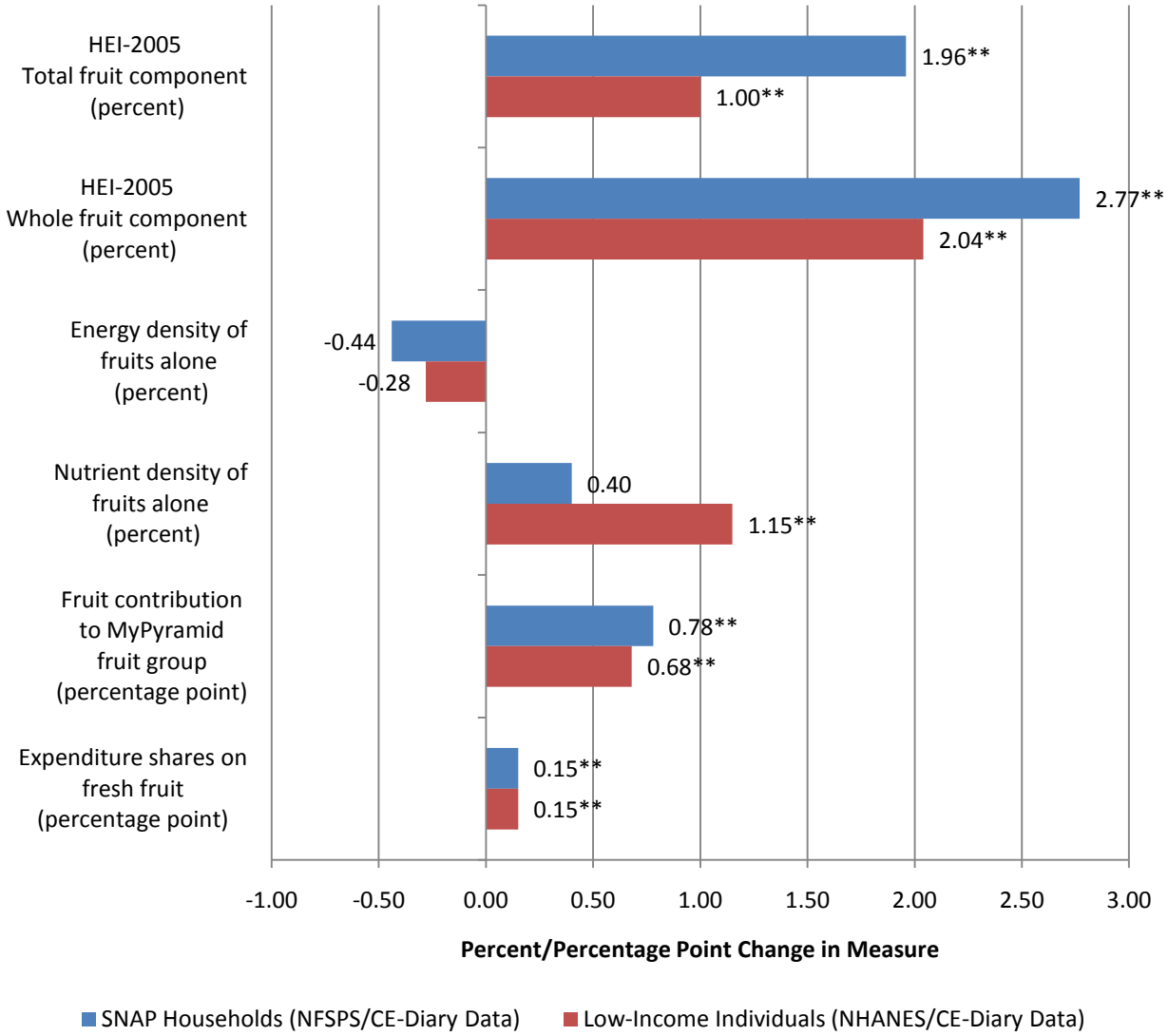
Vegetables

Increased spending on food is also associated with increased use and intake of vegetables, according to several of the measures (Figure 3). Among SNAP participant households, a 10 percent increase in spending on food is associated with an increase of 0.88 percent on the vegetable component of the HEI-2005; for low-income individuals, it is associated with a 1.37 percent increase in the score. For low-income individuals, a 10 percent increase in food spending is also associated with a 0.65 percent decrease in energy density for vegetables and a 1.02 percent increase in nutrient density.

Low-income individuals with higher diet costs consume larger shares of vegetables (as opposed to mixed dishes and other contributors of vegetables) to contribute to their total MyPyramid vegetable group. Expenditures on vegetables, as a percentage of total food expenditures, are also positively associated with spending on food, increasing 0.17 and 0.18 percentage points for SNAP

participants and low-income consumer units, respectively, with a 10 percent increase in expenditures.

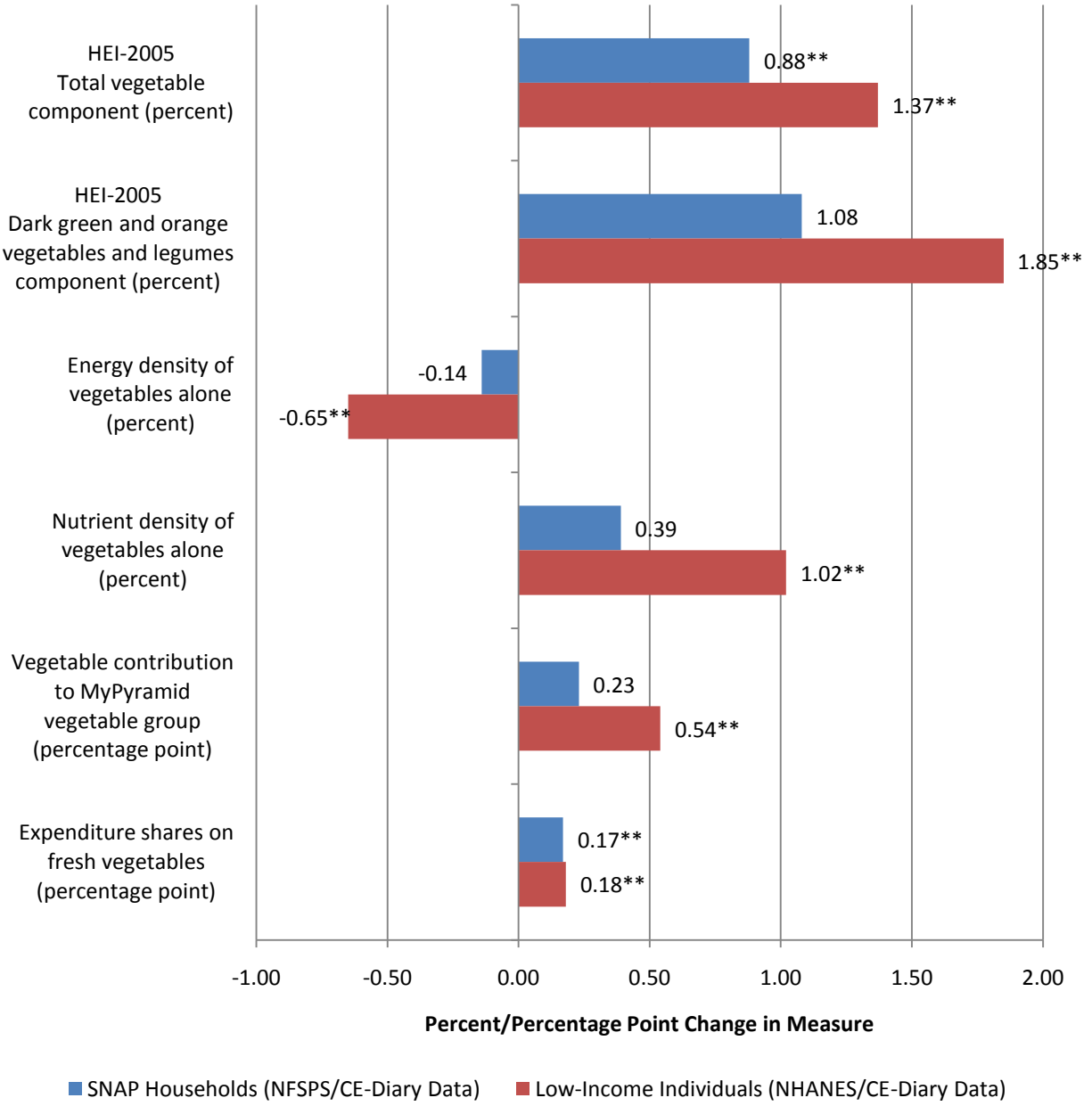
Figure 2. Change in Fruit Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure 3. Change in Vegetable Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

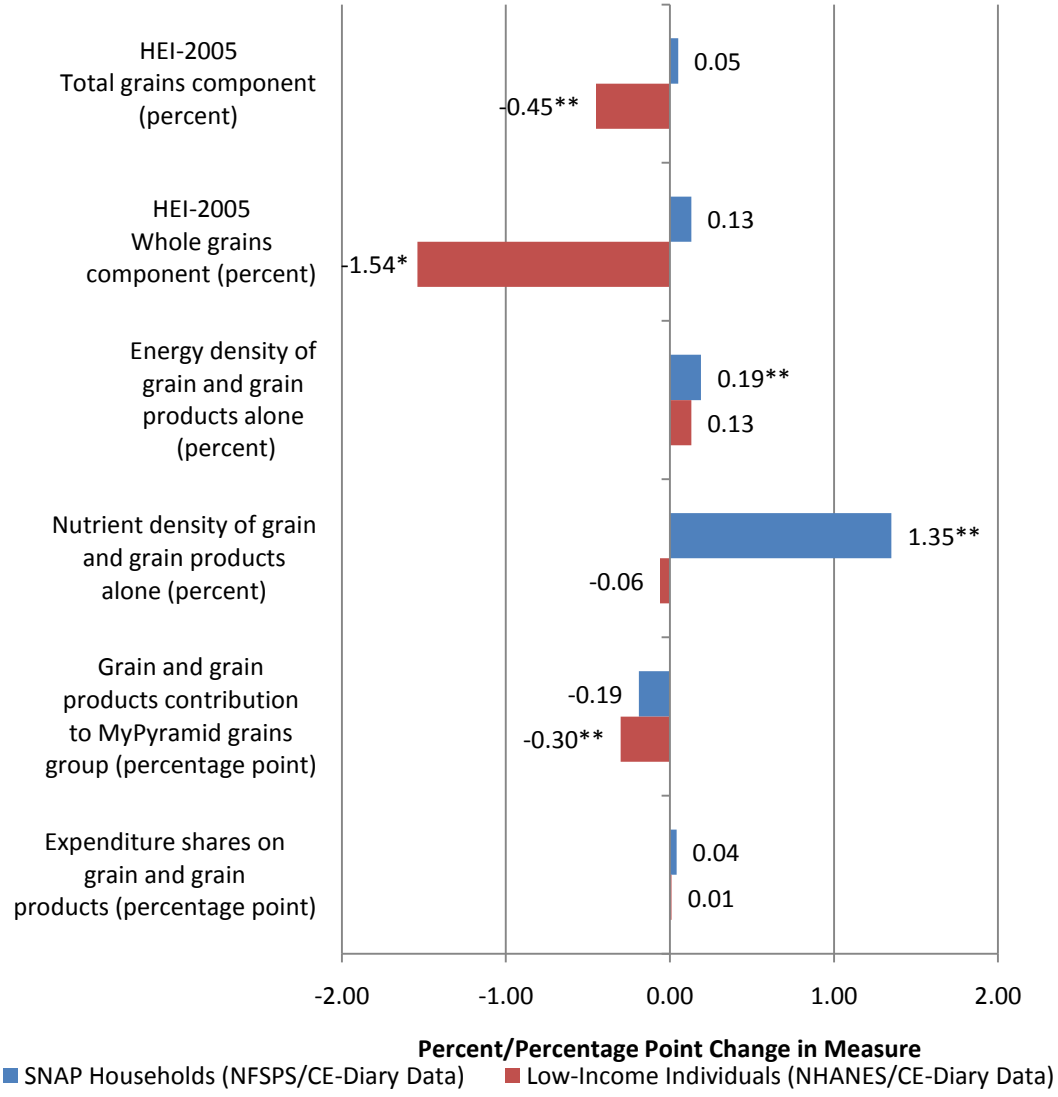
Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Grains

Results for grains are mixed, with both positive and negative findings (Figure 4). The HEI-2005 measure includes points based on both total grains and whole grains. A 10 percent increase on food spending is associated with a decrease in HEI-2005 component scores for grains for low-income

individuals (-0.45 percent). The HEI-2005 component score for whole grains, which have seen more of a focus than total grains in recent public health discussions, show a larger decrease than total grains (-1.54 percent). In addition, SNAP participants with higher spending on food use grains that are more energy dense, that is, higher in calories per gram. However, the SNAP participants with higher spending use grains that are more nutrient dense (a 10 percent increase in food spending is associated with a 1.35 percent increase in nutrient density). Low-income individuals with higher diet cost consume a smaller share of total grains from grains and grain products, as opposed to frozen, carry-out, deli-prepared foods, sweets, desserts, and salty snacks, than those with lower diet cost.

Figure 4. Change in Grain Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



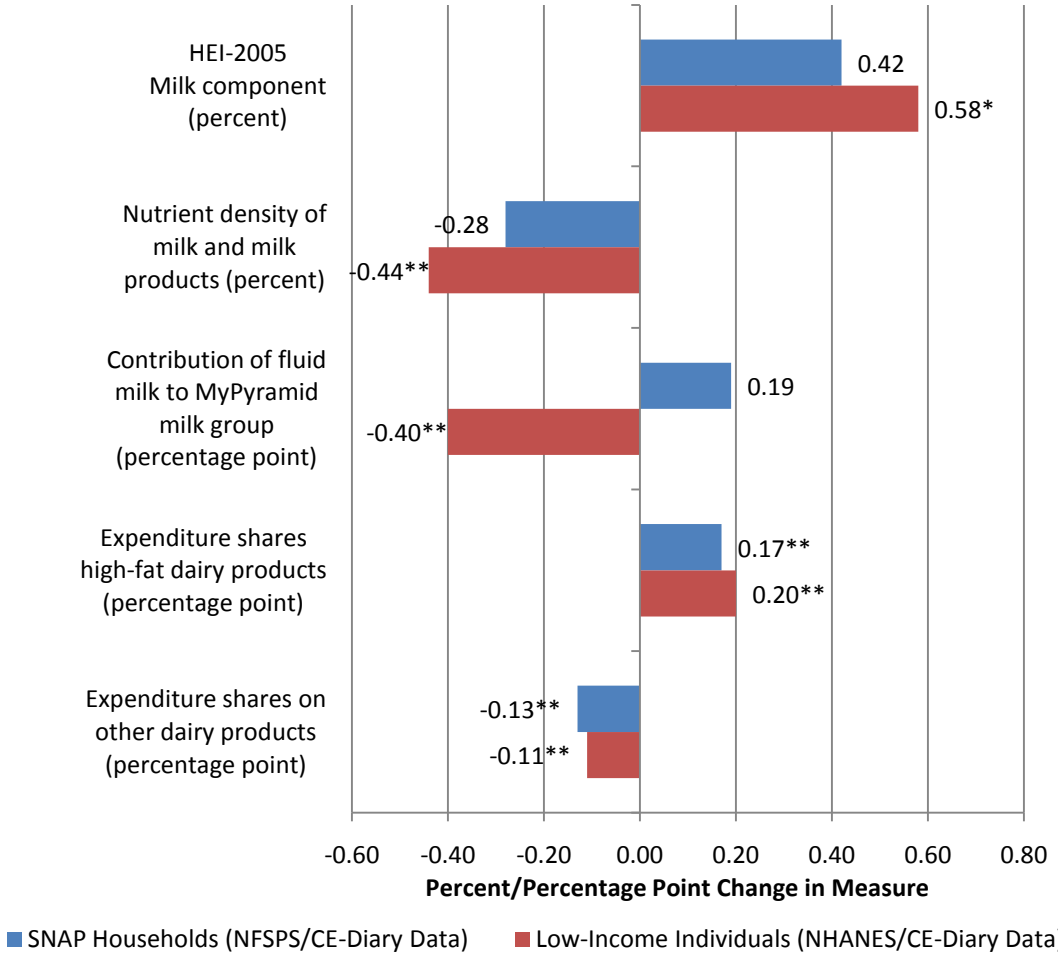
Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Dairy

Low-income individuals with higher diet cost have a higher HEI-2005 component score for milk than those with lower diet cost (Figure 5), suggesting higher consumption of milk and milk products. However, they consume milk and milk products that are lower in nutrient density, suggesting fewer nutrients per calorie in the milk and milk products consumed. (The energy density measure does not include liquids and so is not included here.) Low-income individuals also consume a smaller share of total milk from fluid milk, and thus more from cheese and milk products, than those with lower diet costs. As a percentage of expenditures on food, SNAP participants and low-income consumer units who spend more on food spend a higher proportion on high-fat dairy products (including cream, cheese, and ice cream) and a lower proportion on other types of dairy products (including powdered milk and fresh, canned, and non-frozen yogurt).

Figure 5. Change in Dairy Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Desserts, Sweets, and Salty Snacks

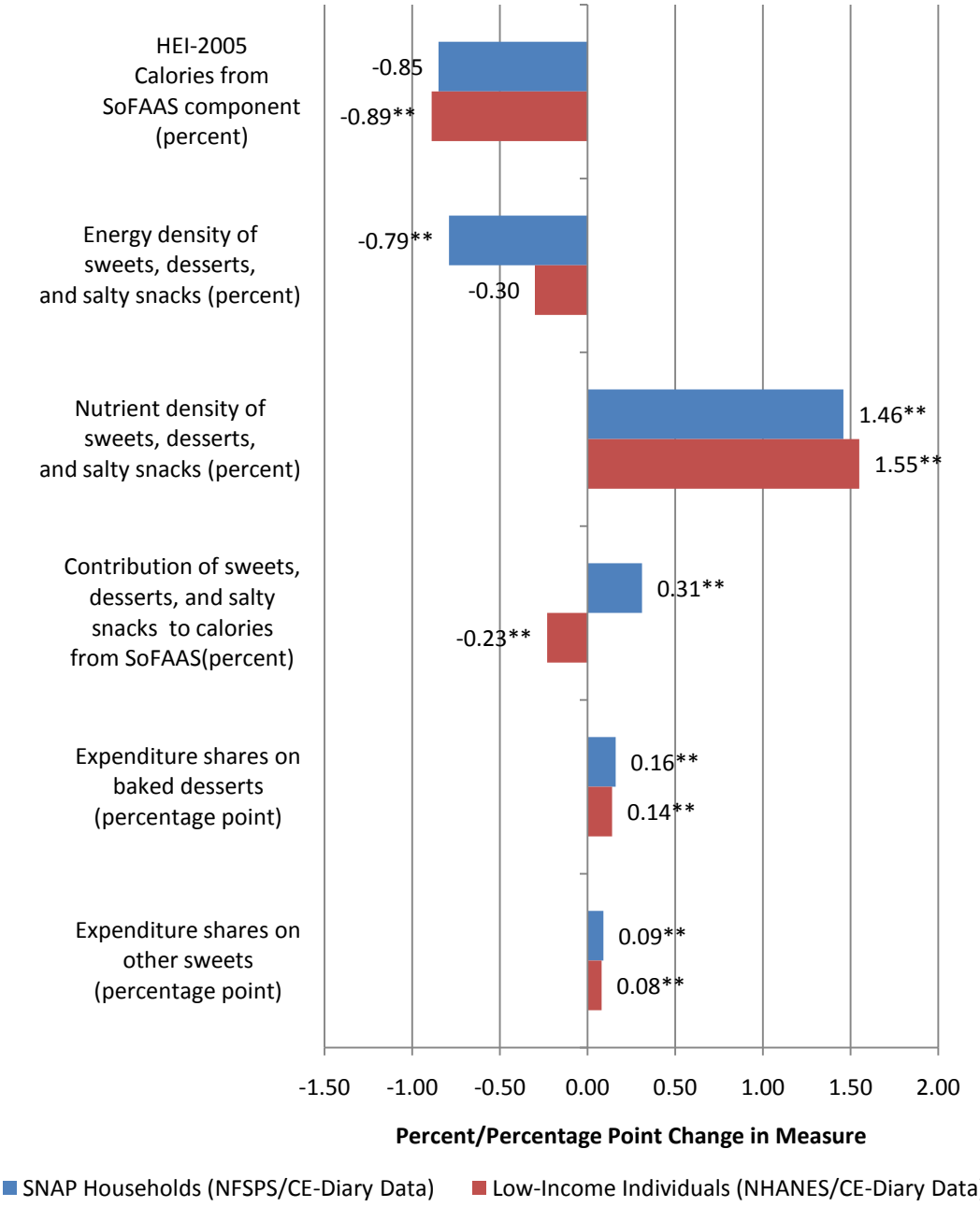
The results for use and intake of desserts, sweets, and salty snacks are also mixed (Figure 6). A 10 percent increase in food spending is associated with a lower score on the HEI-2005 component for calories from SoFAAS for low-income individuals. For SNAP participants who spend more on food, as measured in the NFSPS, more of the calories from SoFAAS come from sweets, desserts, and salty snacks than for those who spend less on food. For low-income individuals in NHANES, fewer of the calories from SoFAAS are from sweets, desserts, and salty snacks. SNAP participants and low-income individuals who spend more on food also spend more on baked desserts and other desserts as a percentage of their total food spending than those who spend less on food. However, for both SNAP participants and low-income individuals, higher expenditures on food are associated with use and intake of desserts, sweets, and salty snacks that are higher in nutrient density.

Findings by Subgroup

We also examine associations between food spending and diet quality by several subgroups, including age, gender, education, and income. In many cases, the findings for subgroups mirror the findings for the low-income population. Thus, we present selected results in the report, such as the following:

- Low-income children with higher diet cost have slightly higher intakes of iron per 1,000 calories consumed than those with lower diet cost. Older adults with higher diet costs have lower intakes of iron than those with lower diet costs. The relationship is not statistically significant for non-elderly adults.
- Low-income children with higher diet cost consume less energy-dense vegetables and more energy-dense grains and grain products than low-income children with lower diet costs. None of these relationships was significant for adults.
- Low-income individuals with less than a high school education and high diet costs consume vegetables with lower energy density than those with low diet costs.
- Low-income individuals with income from 130 to 300 percent of poverty and high diet costs consume foods that are higher in nutrient density than those with low diet costs, as do low-income females and individuals who are married or living together.

Figure 6. Change in Desserts, Sweets, and Salty Snacks Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Policy Context and Implications

Our basic analytic approach is to use person- and household-level data sets to examine associations between levels of food expenditures and scores on the various indices of diet quality. However, the research and policy implications of our findings are defined by a broader conceptualization of the factors which underlie interest in diet quality—the presumed effect of diet on health outcomes. Assessing this is important from a policy perspective because it is likely that it provides an intermediate measure of how nutrition policy may affect a wide range of health outcomes, including obesity, cardiovascular disease, diabetes, and other diseases.

The overarching goal for this line of research was to address a "link" in the causal chain that underlies the assumption that SNAP participation leads to improved dietary outcomes. It is well documented that SNAP leads households to spend more on food. The question this study sought to address is "Does spending more on food lead to a higher quality diet?" To answer this question, we explored the relationship between food expenditures and several different measures of diet quality using two different data sets that assessed diet quality at the household and individual levels. Our findings are striking in their consistency. As presented in Figure 1, we find a positive and significant relationship between food expenditures and diet quality across all outcome measures and data sets used in the analysis.

Results consistently show that increasing spending on food leads to an increase in overall diet quality; but the increase in the extra amount spent on food may only lead to a slight improvement in the total nutritional value of a household's diet. For example, increasing a household food budget by 10 percent may only lead to a 1 percent increase in that household's overall nutritional intake. This means that a person who already consumes an average quality diet might only improve his or her diet marginally from the average. Finally, increasing the household food budget by more than 10 percent may lead to a larger improvement in diet quality, although the improvement may not be proportional. For example, increasing the food budget by 20 percent, versus 10 percent, may not lead to twice the improvement in diet quality.

These findings beg the question of how meaningful these relationships between food expenditures and diet quality are from an economic, nutrition, or health policy perspective. Conceptually, it would be desirable to explicitly link the observed diet quality variables to health outcomes, particularly when assessing the sizes of observed associations in the data. FNS has moved in this direction with their Strategic Plan for 2005-2010, which sets a goal to increase mean HEI scores among individuals with incomes below 130 percent of poverty from 62.0 to 65.8, a 6 percent increase (USDA 2006).[4] Our results show that a 10 percent increase in food expenditures increases the HEI-2005 score by about one-third of a percent, or 5 percent toward the stated goal. Given that the mean amount of household expenditures on food per week was $59.13 in 1996 (one of the two survey periods on which our analysis is based), a 10 percent increase in expenditures translates into an extra $6 per week or $26 per month.

We found larger percentage increases in some of the individual HEI-2005 component scores. For example, a 10 percent increase in food expenditures increases the HEI-2005 component score

[4] This goal was based on the original HEI rather than the HEI-2005 used in the current study.

for whole fruit by 3 percent. These results suggest that policies targeting increased expenditures on specific types of foods may go further in improving diet quality.

In summary, the findings of this study consistently show that food expenditures and diet quality are associated for SNAP households and low-income individuals. The assessment is based on a comprehensive set of findings, based on multiple data sets from several survey periods and a rich set of more than a half-dozen dietary quality measures. While these are strong associations in a statistical sense, it is difficult to say whether they are "small" or "large" from a nutrition or health policy perspective. Additional research (which was outside the scope of work for this project) is needed to document the link between diet quality and health outcomes for this population through a comprehensive literature review.

This page has been intentionally left blank for double-sided copying.

I. INTRODUCTION

In administering the Supplemental Nutrition Assistance Program (SNAP),[5] the U.S. Department of Agriculture (USDA) Food and Nutrition Service (FNS) also has the responsibility to continually assess how well the program is working. With a stated goal "to provide for improved levels of nutrition among low-income households" (Food and Nutrition Act 2008), an important measure of success is the extent to which SNAP individuals are able to improve their nutritional intake by participating in the program. Thus, there has long been interest in examining how the program affects food use and dietary quality. Until recently, this concern has focused mainly on the nutrient adequacy of SNAP participants' diets—specifically, the degree to which recipients met their recommended dietary allowance (RDA) levels (Fox et al. 2004a; IOM 2000; Butler 1996). However, with growing recognition of the dangers of being overweight or obese, and with increased understanding of the relationships between disease and dietary composition, the focus of attention in evaluating SNAP has been extended. These broad concerns are reflected in the development of the Dietary Reference Intake (DRI) standards (IOM 2006) and in the eating recommendations provided by the *Dietary Guidelines for Americans* (DGA) (DHHS 2005). FNS also convened an expert panel to examine the relationship between SNAP participation and overweight (USDA 2004).

Despite these broader concerns about diet quality, the bulk of the past empirical work assessing program effects has focused on food expenditures, defined as the dollar value of foods bought (or in some studies, foods used from household supplies), including those purchased with SNAP benefits and with cash (Fox et al. 2004). This focus has reflected both the greater availability of food expenditures data, as compared to dietary quality data, and the fact that focusing on expenditures provides a single measure of outcomes, as compared to the many different possible measures of nutritional quality.

In assessing the effects of SNAP on expenditures, most researchers have focused on the increase in food expenditures resulting from a dollar increase in benefits (technically, the marginal propensity to consume). It has long been recognized that an additional dollar of benefits is unlikely to lead to a comparable increase in food expenditures because, to some extent, the SNAP benefit can be substituted for money that the household would have spent on food out of its own resources. Indeed, the findings of most researchers have suggested that the increase in food spending, defined as "the marginal propensity to consume food out of SNAP benefits," is in the range of $0.17 to $0.45. Because the comparable estimates for food spending out of regular income are in the range of $0.10, these findings have suggested that SNAP benefits do have an effect on food spending, though not a dollar-for-dollar effect (Fraker 1990; Burstein et. al 2005).

A. A Link in a Chain of Studies

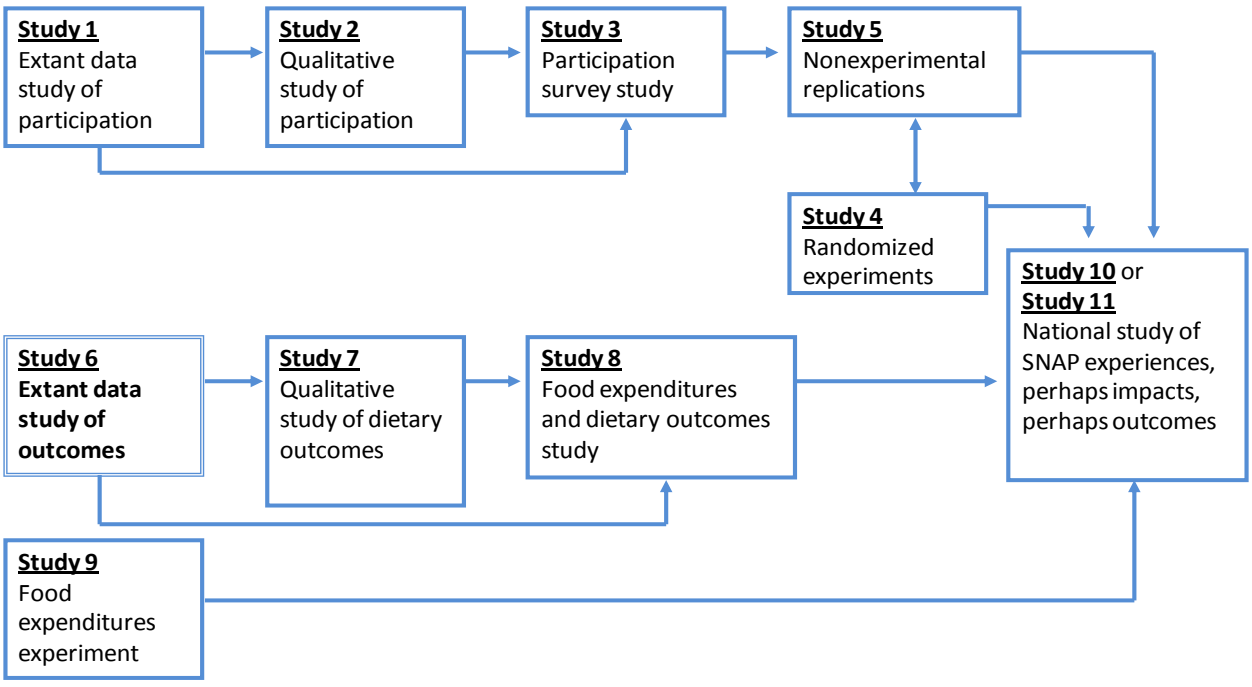
In light of concerns about the nutritional quality of people's diets and the effects on their health, there has been increased interest in trying to examine the effects of SNAP on nutritional outcomes. In particular, a 2003 Performance Assessment Rating Tool (PART) recommendation was that the USDA "develop studies to demonstrate the impact of program participation on hunger and

[5] On October 1, 2008, the Food Stamp Program changed its name to the Supplemental Nutrition Assistance Program (SNAP).

dietary status."[6] To address this recommendation, FNS contracted with Abt Associates to assess ways to better isolate SNAP effects on nutritional outcomes. Working with a four-person expert panel, they recognized that a random assignment experiment that provides benefits to a treatment group and not to a control group is the ideal evaluation design. In particular, it would overcome the primary concern that any study with a nonexperimental design would be subject to selection bias. In other words, any associations identified between improved diet quality and SNAP participation could not be differentiated from characteristics that led people to decide to participate. However, the panel also recognized the high potential costs and legal and ethical issues associated with a random assignment design (Burstein et al. 2005).

The panel concluded that further study could progress along two tracks: one to address selection bias and the other one to assess the relationship between SNAP participation and outcomes. The selection bias studies, shown as Studies 1 through 5 in Figure I.1, would identify factors that influence program participation decisions, then test how well these factors could be controlled for in nonexperimental designs. The outcome studies, shown as Studies 6 through 9, examine the relationships between food expenditures, the quality of the household food supply, and individual dietary intake; that is, they examine the links highlighted in Figure I.2. Finally, if these studies demonstrate that a nonexperimental evaluation can control for selection bias and a positive association exists between food expenditures and dietary intake when not controlling for selection bias, then there is empirical evidence to proceed with a large national study of SNAP and its outcomes (Studies 10 and 11 in Figure I.1).

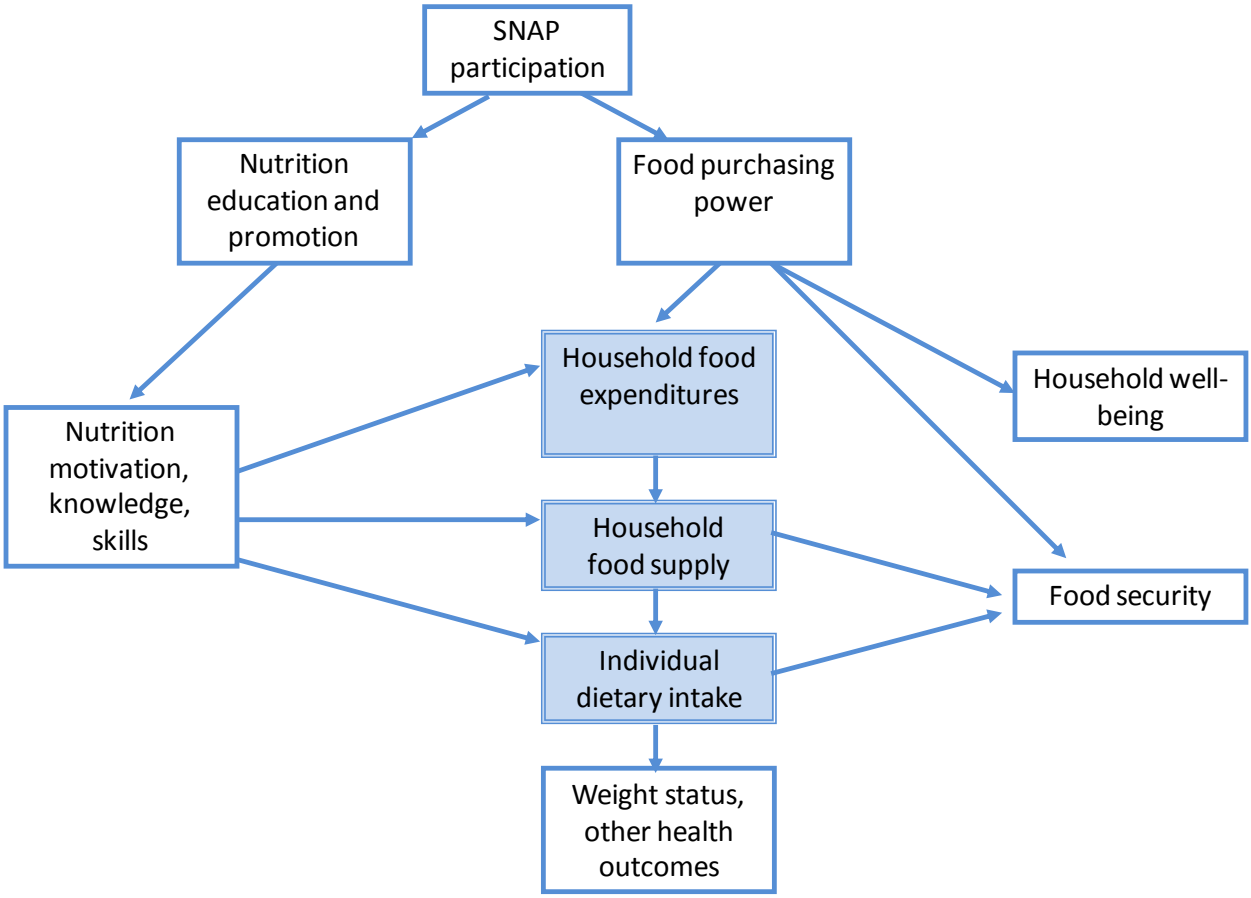
Figure I.1 Chain of Studies Proposed to Assess Nutritional Outcomes of SNAP



Source: Burstein et al. 2005

[6] http://www.whitehouse.gov/omb/expectmore/detail/10001007.2003.html.

Figure I.2 Hypothesized Steps from SNAP Participation to Better Health



Source: Burstein et al. 2005

Thus, the goal for the complete set of studies is to evaluate the effectiveness of SNAP in improving participants' health by conducting several overlapping studies, each informing the design and usefulness of the next.

For example, we know from previous studies that increasing SNAP benefits leads to more money spent on food. The next question, and the purpose of this report, is to identify whether spending more money on food leads SNAP participants and, more generally, other low-income individuals, to purchase and consume more nutritious foods.

B. Research Questions

The current study represents Study 6 in Figure I.1, using extant data sources to study dietary outcomes. In particular, the goal is to:

- Describe and compare the relationship between food expenditures and food use patterns among households, as mediated by a variety of factors, including participation in SNAP.

More specifically, we address the following research questions:

- Among low-income households and individuals, is an increase in food expenditures associated with an increase in nutritional quality of diets?
- What factors or household characteristics mediate these relationships?
- Does the relationship between food expenditures and quality of the household food supply vary between SNAP households, other eligible households, and higher income households?

Thus, in this study, we seek to quantify the relationship between spending on food and the quality of individual and household diets.[7]

C. Overview of Research Approach

The details of the research approach are discussed in Chapter II. We provide a short review here of the nutritional quality measures we use, the data, and the general approach.

We evaluate nutritional quality using six distinct measures because no single, generally accepted measure exists. The measures that we chose allow us to examine various aspects of diet quality—measures that examine foods as well as nutrients and that differentiate between nutrients that are of concern because of potential inadequate intakes and those that are of concern because of potential excessive intakes. The six measures are:[8]

- Scores on the **Healthy Eating Index (HEI)-2005** dietary quality scale. The HEI-2005 measures food quality in relation to the most recent federal dietary guidelines in the MyPyramid food guidance system (USDA 2007) and provides a composite measure of food quality, as well as 12 components. (See Chapter III.)
- **Nutrient availability/intake**, including essential vitamins and minerals, fiber, and nutrients and food components, including ones that are at risk of underconsumption and ones that are of concern because of potential overconsumption, scaled to a per 1,000 calories available basis. (See Chapter IV.)
- **Energy density**, measuring calories provided per gram of food available. (See Chapter V.)

[7] This work was conducted in conjunction with the analysis presented in the report, "Low-Income Household Spending Patterns and Measures of Poverty." That report examines spending patterns of SNAP participants and nonparticipants and the use of savings and credit across these groups. Because households are likely to make food purchase decisions jointly with spending decisions on other goods and services such as housing, transportation, and health, the two sets of findings are closely related.

[8] We also examine usual energy and nutrient intakes, assessing whether spending more on food per calorie consumed is associated with the nutritional adequacy of diets consumed by low-income individuals. Because of methodological constraints associated with this measure, the results are not directly comparable with the other measures of diet quality considered here. We discuss the results for this additional measure in Appendix B.

- A measure of **nutrient density** called the Modified Naturally Nutrient Rich (NNR) score, which is a nutrients-to-calories ratio, identifying the concentration of 16 vitamins and minerals, fiber, and protein, relative to energy content. (See Chapter VI.)
- **Food shares**, capturing the availability of foods in the household by major food group, on the basis of cup or ounce equivalents per 1,000 calories available. (See Chapter VII.)
- **Share of food expenditures spent on food categories**, measuring the percentage of total food expenditures that has been allocated to foods recommended for frequent consumption, foods not recommended for frequent consumption, and other foods. (See Chapter VIII.)

As indicated in Table I.1, the measures provide different types of information. Several of them provide a summary or composite number and some can only be used to examine specific categories of food or nutrients.

Table I.1 Type of Diet Quality Information Provided by Each Measure

	Type of Measure		
	Composite/ Summary	Food Categories	Nutrients Provided
Measure of Nutritional Quality			
Healthy Eating Index–2005	✓		
Nutrient Availability			✓
Energy Density	✓	✓	
Nutrient Density	✓	✓	
Food Shares		✓	
Food Expenditures	✓	✓	

As with the diet quality measures, no single data source is ideal for examining nutritional quality, so we use three extant data sources:

- The **National Food Stamp Program Survey** (NFSPS), collected in 1996 by Mathematica Policy Research.
- The **National Health and Nutrition Examination Survey** (NHANES) for 2001-2002 and 2003-2004, originally developed by the National Center for Health Statistics and modified by the U.S. Department of Agriculture's Center for Nutrition Policy and Promotion (CNPP) with prices for foods.
- The diary component of the **Consumer Expenditure Survey** (CE), collected in 2005 by the U.S. Census Bureau for the Bureau of Labor Statistics.

The data sources that we use for each of the outcome measures are identified in Table I.2. We use a variety of descriptive statistics and multivariate analysis, depending on the outcome measure and data source.

Table I.2 Data Sources and Outcome Measures

	NFSPS	NHANES	CE–Diary
Measure of Nutritional Quality			
Healthy Eating Index–2005	✓	✓	
Usual Dietary Intake		✓	
Nutrient Availability	✓	✓	
Energy Density	✓	✓	
Nutrient Density	✓	✓	
Food Shares	✓	✓	
Food Expenditures			✓
Participation and Eligibility Group			
SNAP Participants	✓	✓	✓
Eligible Nonparticipants		✓	✓
Ineligible Nonparticipants		✓	✓

II. METHODOLOGY

In this chapter we describe the data and methods used to examine the relationship between expenditures and diet quality. We begin by discussing the variables used in the analyses for each data set. We then define several dimensions of diet quality, how they are measured, and how they differ across data sets. Limitations of the data and analysis, as well as how they may affect the findings, are also discussed.

A. Data

The analyses in this study use data from three national data sets: the National Food Stamp Participant Survey (NFSPS), the National Health and Nutrition Examination Survey (NHANES), and the diary component of the Consumer Expenditure Survey (CE-Diary). In this section we describe the data sources and the sets of variables included in each analysis. Table II.1 provides information about the relevant content of each of the data sets.

Table II.1 Summary of Relevant Content of NFSPS, CE-Diary, and NHANES Data

	Data Sources		
Feature	National Food Stamp Participant Survey	National Health and Nutrition Examination Survey with Appended Price Data	Consumer Expenditure Survey—Diary
Analysis Years for Proposed Study	1996	2001–2004	2005
Total Sample Size	957 seven-day records	10,000 24-hour recall records	15,000 seven-day records
SNAP Participants	957 seven-day records	877 24-hour recall records	750 seven-day records
Unit of Analysis	Household	Individual	Consumer Unit
SNAP Benefit Receipt	Received SNAP benefits in last 30 days	Authorized to receive SNAP benefits in the past 12 months	Received SNAP benefits during last month
Amount	Amount of SNAP benefits received most recently	Amount of SNAP benefits authorized to receive	Amount received in the last month
Number of months received	No information	How many of the last 12 months	How many of the last 12 months
Food Expenditures and Use			
Food use	Food used from household food supply	Food consumed	Food purchased
Food at home	Aggregate food expenditures for seven-day period	Value of food eaten; can be built up from detailed 24-hour food consumption data and the price per food. Average price for each food provided by data from USDA's Center for Nutrition Policy and Promotion using Nielsen Homescan food store price information. Assumes all food is prepared at home by assigning price of convenience products available in the grocery store, if necessary.	Sum of weekly totals for food purchased for home consumption in the following categories: cereal & grains, bakery products, beef, pork, poultry, other meats, fish & seafood, fats & oils, eggs & dairy, fruits and juices, sugar & sweets, vegetables, nonalcoholic beverages, alcoholic beverages, and other foods.

Table II.1 *(continued)*

Feature	Data Sources: National Food Stamp Participant Survey	Data Sources: National Health and Nutrition Examination Survey with Appended Price Data	Data Sources: Consumer Expenditure Survey—Diary
Food away from home	Usual weekly or monthly amount spent for food bought and eaten away from home. Includes food and beverages that never entered home, including, eaten at restaurants, fast-food eating places, cafeterias at work or at school, purchased from vending machines, or received from day care centers.	Assumes all food is prepared at home.	Sum of the weekly totals for food purchased at fast food, take-out, delivery restaurants or cafeterias, full-service restaurants, vending machines, school or employer cafeterias. Note that board and catered affair amounts are not included in the summary variable.
Other Information	Asks for and subtracts out the amount spent on nonfood items.	NA	NA
Time unit	Weekly or monthly expense, but variable is recoded to monthly.	24 hour	Based on diary of purchases over two consecutive seven-day periods.
Food items	1 record per food: food code, description, weight of food used, nutrient content.	1 record per food: food code, description, weight of food consumed, nutrient content.	Expense
Nutrients and Calories	Nutrients and Calories available, including Protein, Vitamin A, Vitamin C, Vitamin E, Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Calcium, Phosphorus, Magnesium, Iron, Zinc, Fat, Saturated Fat, Fiber, Potassium, Sodium	Nutrients and Calories available, including Protein, Vitamin A, Vitamin C, Vitamin E, Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Calcium, Phosphorus, Magnesium, Iron, Zinc, Fat, Saturated Fat, Fiber, Potassium, Sodium	No information
Food-Related Characteristics			
Food insufficiency	General worries about food insufficiency, skipping of meals, food insecurity index.	General worries about food insufficiency, skipping of meals, food insecurity index.	No information
Food knowledge	Food pyramid serving knowledge index.	No information	No information
Gross Income	Household monthly gross income	Household and family annual income categories; family income to poverty ratio	Household gross income before taxes in past 12 months
Included as gross income	Total earnings, Social Security, Supplemental Security Income, Unemployment Compensation, Veterans benefits, welfare, retirement benefits, income from boarders, child support, other income.	No information.	Wages and salary, nonfarm business, farm income, Social Security and Railroad retirement, Supplemental Security Income, unemployment, Worker's Compensation or Veterans benefits, welfare, interest, dividends and royalties, pensions and annuities, roomers and boarders, other rental units, alimony, child support, other money income, SNAP benefits.
Time unit	Monthly	Annual (last 12 months)	Annual (last 12 months)
Demographic Characteristics	1 record per household: presence of children in household; number of dependent children under age 13; any children under age 18, under age 19, under age 20; age, race, sex, marital status for respondent.	1 record per individual: age, sex, race, marital status for respondent. No information on household or family size, presence of children, or household composition.	1 record per consumer unit: number of persons under age 18, over age 64; age, race, sex, education, Hispanic origin of Head and Spouse; family type (based on relationship with reference person).

1. NFSPS

The NFSPS is used to examine food expenditures and their association with the quality of the home food supply for SNAP participants. It was conducted in 1996 by Mathematica for FNS and was designed to obtain survey information from SNAP participants and eligible nonparticipants to assess key aspects of how well the program is meeting the needs of low-income households requiring food assistance. While the survey includes a nationally representative sample of SNAP participant, SNAP-eligible nonparticipant, and SNAP "near-eligible" nonparticipant households, the seven-day food use data used in the current study were only collected for SNAP participants. The final sample containing food use data for SNAP participants includes 957 households.[9,10]

Participants in the study were asked to keep a hard-copy diary of their household food use, as well as grocery receipts, food labels, and any other information that would help them in the follow-up interview. Usually within 24 hours of the end of the seven-day period, the respondent participated in an in-home assisted-recall process. The respondent and interviewer discussed each of the foods used and the prices.

The raw data file consists of food-level observations for each household from both the hard-copy diary and electronic data. For each food, the data include a food code, a description of the food, the total amount used (in grams), the calories and nutrients available in that amount, and the total cost. Information from this file is aggregated across all foods to the household level. The resulting data file consists of household-level variables measuring total amounts of nutrients and calories consumed and total food expenditures for the seven-day period.

The NFSPS collected detailed data on all foods used from the household food supply over the seven-day period prior to the interview. This includes (1) all foods eaten at home, including foods from carryout places when the food was brought into the home; (2) foods prepared at home but eaten outside the home; and (3) plate waste such as food that was prepared at home but thrown away or given to a pet.[11] The NFSPS food use measure does not include leftovers, defined as foods prepared but not yet eaten. Additionally, food purchased and consumed away from home are not included in the NFSPS.

The NFSPS data also includes costs for foods. For identifying food expenditures in this study, we use the costs of the foods used during the week.

The multivariate analyses for this study use different sets of variables describing the socioeconomic and demographic characteristics of households. These include:

---

[9] For some of the 1,109 households interviewed in person, four days of food use data were collected instead of seven. We limit the analysis to the seven-day food use data only.

[10] Although SNAP participants were selected to be nationally representative, comparisons with other nationally representative samples of SNAP participants revealed that there is some tendency for those in the NFSPS to be (a) more likely to be elderly, (b) less likely to receive welfare payments, and (c) more likely to have earnings (Cohen et al. 1999).

[11] Meals provided to guests are included in the totals, with 21 percent of households reporting at least one guest meal over the seven-day period. Initial testing of the effect of controlling for guest meals showed no impact on the results.

- Household composition such as variables indicating whether (1) there are multiple adult household heads, (2) there is at least one child in the household, and (3) there is at least one elderly adult in the household
- Geographic residence, such as variables indicating in which of the seven FNS regions the household lives
- Household location, measured by whether the household is located in an urban, suburban, or rural area
- Race and ethnicity of the household head
- Income-to-poverty ratio constructed using a household's gross monthly income

2. NHANES

The NHANES is a continuous survey (since 1999) that collects data on the health and nutritional status of the population through physical examinations and tests at a mobile examination center (MEC), as well as an interview in the home. Interviews are conducted with nationally representative samples of about 5,000 individuals per year, with somewhat fewer completing visits to the MEC. The survey uses a stratified, multistage design to provide a representative sample of the civilian, noninstitutionalized population, while oversampling some high-risk groups, such as African Americans, Mexican Americans, low-income, teenagers, older persons, and pregnant women.

The NHANES includes a wide range of variables. The household interview collects limited data on demographic characteristics, income, housing characteristics, nutrition program participation, and food security, and more detailed information on physical activity, weight history, health insurance coverage, smoking, dietary supplement use and access to health care, among other topics. The subsequent MEC visit includes a 24-hour dietary recall, anthropometric measurements, questions on mental health and risky behaviors, a complete physical exam, a dental exam, and blood and urine tests.

The NHANES data, as originally implemented by the National Center for Health Statistics, do not contain information about food expenditures or food prices. However, the U.S. Department of Agriculture's Center for Nutrition Policy and Promotion (CNPP) used Nielsen Homescan food store price information to attach prices to foods identified in the 2001-2002 and 2003-2004 NHANES.[12] Specifically, the NHANES data, as modified by CNPP (referred to throughout as the "NHANES data with appended price data"), now include a nationally averaged price for each individual food. This makes it possible to estimate the cost of foods reported for each 24-hour recall on the NHANES file—a total of more than 8,000 food intake observations.[13] With the addition of the price data, we are able to calculate a diet cost, which is the cost for the food the individual

[12] CNPP researchers used the modified NHANES data to identify determinants of expenditure patterns in the general population. However, they have not done so specifically for the low income, SNAP-eligible population, which is the main focus of the current contract.

[13] The price data did not include prices for alcoholic beverages. We imputed prices for these as described in Appendix J. We verified that selected results were not sensitive to this imputation and also provide those results in the appendix.

consumed on the day of the 24-hour recall. This price information is only available for the 2001-2002 and 2003-2004 NHANES files.

Unlike the NFSPS, which provides food use data only for SNAP participants, NHANES can be used to examine variations in diet quality by income and SNAP eligibility. Because the low-income population is the focus of the study, we limit the analysis to SNAP participants and those with income under 300 percent of poverty.[14] We further divide the low-income nonparticipants into two groups: (1) the eligible nonparticipants, which we define as nonparticipants with income at or under 130 percent of poverty (that is, those who appear income eligible for SNAP under federal rules), and (2) ineligible nonparticipants, which we define as the nonparticipants with income between 130 and 300 percent of poverty. NHANES does not include information about assets so we cannot account for asset eligibility in this determination.

3. CE-Diary

We use 2005 CE-Diary data to examine the relationship between food expenditures and the quality of the household food supply for SNAP participants in comparison to income-eligible nonparticipants and higher income households. The CE-Diary is one of two surveys that make up the Consumer Expenditure Survey that collects data on household expenditures for goods and services used in day-to-day living for American consumers. It is designed to obtain detailed expenditure data on small, frequently purchased items such as food. The second, the CE-Interview, is a quarterly household interview survey and is designed to collect information on expenditures that respondents can remember for a period of three months or longer. The samples for the two surveys are drawn separately and each survey has its own data collection technique.

The CE-Diary is a record of daily expenses that is kept by a respondent from each consumer unit for two consecutive seven-day periods. The two seven-day diaries are collected from about 7,500 consumer units per year, resulting in about 15,000 seven-day records on the analysis file. Consumer units are defined as members of a household consisting of (1) occupants related by blood, marriage, adoption, or some other legal arrangement; (2) a single person living alone or sharing a household with others, but who is financially independent; or (3) two or more persons living together who share responsibility for at least two out of three major types of expenses—food, housing, and other expenses. Students living in university-sponsored housing also are included in the sample as separate consumer units. The data are weighted to represent the total U.S. civilian noninstitutionalized population.

The CE-Diary survey collects information on food for home consumption by broad food groups as well as by individual foods (see Table II.2 for a sample list of food groups and food items within those groups). For each food purchased for home consumption, the respondent records the item, the total cost, and some information about the item (such as whether fresh, frozen, or canned).

[14] The choice of 300 percent of poverty as a top limit for our analysis sample is somewhat arbitrary. We chose it because (1) it provides a comparison sample that is not likely to be eligible for transfer programs yet is still likely to have spending patterns that are worth comparing to the low-income sample, and (2) it is a fairly common break-point for the identification of low-income households (for example, Currie and Grogger 2001). In fact, half of the states have income limits for Medicaid and State Children's Health Insurance Programs that are set at 250 percent (15 states) or 300 percent (10 states) of poverty; only 1 state has a threshold above 300 percent of poverty (Kenney and Pelletier 2009).

Table II.2 Sample Food Groups and Food Items Within Groups Available in CE-Diary Data Set

Food Groups	Food Items
Fresh Fruit	Apples Bananas Oranges Other fresh fruits Citrus, excluding oranges
Other Fruits	Canned fruits Dried fruits Frozen fruits
Fresh Vegetables	Potatoes Lettuce Tomatoes Other fresh vegetables
Other Vegetables	Frozen vegetables Canned beans Canned corn Miscellaneous vegetables not collected in separate category Other processed dried vegetables, such as squash, not collected in separate category Dried carrots, onions, leafy greens, and cabbage Frozen vegetable juices Fresh/canned vegetable juices Prepared salads

Socioeconomic and demographic characteristics of consumer units are used in both the descriptive and multivariate analyses that use CE-Diary data. These include:

- Household composition, such as variables indicating (1) whether the household head is married, (2) whether there is at least one elderly adult in the household, and (3) the number of children in the household
- Geographic residence, such as variables indicating in which of the four Census regions the household lives
- Population density of the area in which the household lives
- Age of the household head
- Race and ethnicity of the household head

The CE-Diary data are also nationally representative and can be used to examine variations in diet quality by income and SNAP eligibility. As with the NHANES, we limit the analysis to SNAP participants and those with income under 300 percent of poverty. We further divide the low-income nonparticipants into two groups: (1) the eligible nonparticipants, which we define as nonparticipants with income at or under 130 percent of poverty (that is, those who appear income eligible for SNAP under federal rules), and (2) ineligible nonparticipants, which we define as the nonparticipants with income between 130 and 300 percent of poverty. CE-Diary does not include information about assets so we cannot account for asset eligibility in this determination.

B. Measures

We compiled a comprehensive set of measures to examine various aspects of diet quality in terms of foods used and consumed as well as the nutrient content of those foods. These measures differentiate between nutrients that are of concern because of potential inadequate intakes and those that are of concern because of potential excessive intakes. Since there is no single, generally accepted measure of diet quality, this study includes 6 distinct measures: (1) the Healthy Eating Index-2005 (HEI-2005) total and component scores; (2) nutrient availability, including essential vitamins and minerals, fiber, and other nutrients; (3) energy density; (4) nutrient density; (5) food shares; and (6) expenditure shares. The food data in the NFSPS and NHANES allow one to construct the first five of these measures, and the food expenditure data in CE-Diary data can be used to construct the final one. Below, we explain the ways in which these measures are constructed for each data set, as well as the major issues associated with their development.

1. The Healthy Eating Index-2005

The Healthy Eating Index-2005 (HEI-2005) (Guenther et al. 2007) provides a composite measure of diet quality, as well as 12 component scores that measure consumption of food and nutrients in relation to the 2005 *Dietary Guidelines for Americans* and the MyPyramid food guidance system (Table II.3) (USDA 2007). Nine components are food-based and assess intakes of MyPyramid food groups and subgroups—total fruit; whole fruit; total vegetables; dark green vegetables, orange vegetables, and legumes; total grains; whole grains; milk; meats and beans; and oils. The remaining three components assess intakes of saturated fat, sodium, and calories from solid fat, alcohol, and added sugar (SoFAAS). Scoring criteria assign higher scores for greater consumption of food-based components, but lower scores for greater consumption of sodium, saturated fat, and SoFAAS. Maximum scores for each component range from 5 to 20. The standards used in assigning component scores are energy adjusted on a density basis (per 1,000 calories). This approach reflects the overarching recommendation that individuals should strive to meet food group and nutrient needs while maintaining energy balance (rather than meeting food group and nutrient recommendations simply by consuming large quantities of food). The per-1,000 calorie reference standards used in the HEI–2005 are based on the assumptions that underlie the recommended MyPyramid eating patterns, reflecting goals for intakes over time and the recommended mix of food groups.[15]

[15] The components of the HEI-2005 are based on dietary guidance that applies to children 2 years of age and older. Thus some of the metrics we use to assess diet quality do not strictly apply to households with children under age 2. For the HEI-2005 analysis using the NFSPS, a household-level data set, we cannot simply remove the young children and the foods they ate from the analysis. Instead, we conducted a sensitivity analysis and determined that the main findings we present in this report are not sensitive to keeping the infants and young children in the sample. The associations with and without excluding infants and young children generally differ by 0.001 percentage points. For example, a one percent increase in expenditures increases the HEI-2005 total score by 0.033 percent when infants and young children are included and increases the score by 0.034 percent when they are excluded. In general, the associations are marginally smaller when infants and young children are included compared to when they are excluded.

Table II.3 Healthy Eating Index–2005

Component	Healthy Eating Index–2005		
	Maximum Score	Standard for Maximum Score	Standard for Minimum Score of Zero
Total Fruit	5	≥ 0.8 cup per 1,000 kcal	No fruit
Whole Fruit (not juice)	5	≥ 0.4 cup per 1,000 kcal	No whole fruit
Total Vegetables	5	≥ 1.1 cup per 1,000 kcal	No vegetables
Dark Green and Orange Vegetables and Legumes[a]	5	≥ 0.4 cup per 1,000 kcal	No dark green or deep orange vegetables or legumes
Total Grains	5	≥ 3.0 oz per 1,000 kcal	No grains
Whole Grains	5	≥ 1.5 oz per 1,000 kcal	No whole grains
Milk[b]	10	≥ 1.3 cup per 1,000 kcal	No milk/dairy
Meat and Beans	10	≥ 2.5 oz per 1,000 kcal	No meat or beans
Oils[c]	10	≥ 12 gm per 1,000 kcal	No oil
Saturated Fat	10[d]	≤ 7% of total energy	≥ 15% of total energy
Sodium	10[d]	≤ 0.7 gm per 1,000 kcal	≥ 2.0 gm per 1,000 kcal
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	≤ 20% of total energy[e]	≥ 50% of total energy
Maximum Score	**100**		

Source: *Healthy Eating Index-2005*, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, CNPP Fact Sheet No. 1, December 2006.

Note: With the exception of saturated fat and sodium, amounts between the minimum and maximum are scored proportionately.

[a]Legumes are counted as vegetables only after the standard for meat and beans is met.

[b]Includes all milk products, including fluid milks, yogurt, and cheese.

[c]Includes nonhydrogenated vegetable oils and oils in fish, nuts, and seeds.

[d]Saturated fat and sodium get a score of 8 for levels that reflect 2005 *Dietary Guidelines* recommendations: <10% of energy from saturated fat and 1.1 gm sodium per 1,000 kcal, respectively.

[e]The most generous allowance for discretionary calories in the MyPyramid food intake patterns (based on age, gender, and level of physical activity) is 20 percent of total energy.

The density standards used in assigning scores for the various HEI-2005 components provide straightforward and easily understood metrics for assessing the relationship between food expenditures and the diet quality of individuals and households. The HEI-2005 has an advantage over simple food-level estimates because for each individual or household it captures the contribution that each food makes to individual components of MyPyramid. For example, a beef and bean burrito contributes simultaneously to the positive measures of total vegetables, total grains, and meats and beans, as well as to the negative measures of sodium, saturated fat, and calories from SoFAAS. In addition, the SoFAAS measure included in the HEI-2005 is a particularly attractive one for this study because it provides a useful tool for assessing the relationship between food expenditures and major contributors to overconsumption of energy.

Much of the data needed to estimate HEI-2005 scores and to assess sources of MyPyramid food group intake are not available in the NFSPS and NHANES data sets and are obtained from the MyPyramid Equivalents Database (MPED). We discuss this linking in Appendix A.

2. Nutrient Availability

By measuring nutrient availability, we are able to assess whether SNAP households or other low-income individuals that spend more money for food have more essential nutrients and fiber available, and whether they tend to limit their amounts of fat, sodium, and cholesterol.

Included in the NFSPS data are the total amounts of essential vitamins, minerals, fiber, and macronutrients (total fat, saturated fat, carbohydrate, and protein) contained in each food used by household members. We focus on the following nutrients in the analysis:

- Vitamins and minerals: vitamins A, C, B6, B12 and E, folate, thiamin, riboflavin, niacin, calcium, magnesium, phosphorus, iron, and zinc.
- Nutrients and food components that are of public health interest because of problems with over- or underconsumption, some of which are not included in the HEI-2005: total fat, saturated fat, carbohydrate, protein, cholesterol, and fiber. Data on total fat, saturated fat, carbohydrate, protein, cholesterol, and fiber are available in the NFSPS and NHANES data sets. Data on alcoholic beverages are obtained from the FNDDS and data on added sugars are obtained from the MPED (Friday and Bowman 2006).
- For each of these items except total fat, we sum the content from all the foods used and normalize the sum based on the total calories available from all foods used, with much of the analysis being conducted on a per-1,000-calorie basis. For calorie-bearing nutrients and food components, such as total fat and protein, we measure availability on the basis of percentage contribution to total available calories rather than on a unit-per-1,000-calorie basis. In addition, for total fat, saturated fat, carbohydrate, protein, and fiber we created categorical/binary variables that indicate whether the concentration of the nutrient/food component is consistent with dietary recommendations. We summarize these variables and the standards that were used in Chapter IV.

The normalization by total calories increases the comparability of nutrient data across households. Two alternative normalizations, both of which have been used in prior, related studies, recognize that a household's food use is likely to be greatly influenced by its size and by the age and gender of its members; they reflect this by dividing nutrient data by one or two measures of household composition: Adult Male Equivalent (AME) and Equivalent Nutrient Unit (ENU). This essentially places the nutrient measures of interest on a per-AME or a per-ENU basis and has the effect of normalizing the outcomes on household composition, thereby affording increased comparability across households in the analytic work.

The AME is designed to take into account variation in household nutrition requirements resulting from differences in the size and composition of households as well as differences in household members' ages and genders. The approach recognizes that the nutrition requirements (usually, in the case of AMEs, measured in terms of food energy needs) vary among household members. In calculating AMEs, these requirements are computed separately for each member of a household and then summed across members. The ENU incorporates an approach similar to that of

the AME, but also adjusts for meals not eaten from home food supplies by subtracting those meals out of assumed household requirements from home food supplies.[16]

Unfortunately, the AME and ENU variables currently on the NFSPS file were computed using the recommended dietary allowances (RDA) that were in effect in 1989, and are thus outdated. In particular, guidelines about nutrition requirements have been modified significantly as part of the development of the Dietary Reference Intakes (DRIs) by the Institute of Medicine in the past 10 years. Indeed, the practice of assessing dietary intake (or in this case, household nutrient availability from foods used in the household) data on the basis of proportional contribution to RDAs has fallen into disfavor. The DRIs specifically moved away from reliance on RDAs and developed other reference standards for assessing intakes of population groups. The IOM Committee charged with developing guidelines for interpreting and using the DRIs specifically recommended against using RDAs to assess intakes of groups (IOM 2000). Using AMEs and ENUs that are based on RDAs, whether the 1989 RDAs or the updated RDAs included in the DRIs, would be inconsistent with this recommendation.[17]

Using the per-1,000-calorie normalization instead represents a move to a nutrient density approach, since it involves essentially examining nutrients per 1,000 calories available to the household. It has the effect of providing normalization (different from the AME and ENU measures) on both household composition and meals eaten away from home. In particular, small households, households with relatively small children, and households who have eaten meals outside the home would, other things equal, be expected to have not only less nutrient intake (because a smaller number of foods would be recorded in the diary), but also less food energy consumption. We recognize that this is considerably different than accounting for differences in composition of households using the AME and ENU measures. In light of this, we are accounting for household composition by including the number of AMEs in a household on the right-hand side of our multivariate regressions.

An obvious disadvantage of this normalization is that, by definition, it cannot be used to compare food energy use across households. That is, some households may have more nutrients available because they eat more of both high- and low-energy foods. However, as issues of energy density have become more important in public health assessments, this normalization approach has provided an attractive alternative. Indeed, the recently published HEI-2005 is largely based on the normalization of dividing through by 1,000 calories.

The per-1,000-calorie normalization is also used in the NHANES analysis. Even though this analysis is performed at the individual level (unlike the NFSPS), this normalization is helpful in accounting for differences in energy intakes across observations.

---

[16] While the AME measure has traditionally been defined on the basis of food energy requirements, multiple ENU factors are often computed, based on other nutrient requirements as well. Thus, for instance, a study that is examining a total of, say, 10 nutrients, such as food energy plus a set of nine selected vitamins and minerals, might compute a set of 10 different ENUs, one for each nutrient of interest.

[17] Converting the existing RDA values to the new standards is very difficult, not only because the recommended levels have changed for some nutrients, but because key aspects of the *underlying structure* of the RDAs has changed. This includes changes in the age groups used in defining standards as well as changes in the units of measurement for some nutrients. Thus the required adjustments are more complicated than just proportional changes.

The NHANES also contains several nutrients that are not available in the NFSPS: phosphorus, monounsaturated and polyunsaturated fats, linoleic and linolenic acids, and cholesterol.

3. Energy Density

Although energy is an important part of diet quality, increased energy availability is not always a good outcome. It is not possible with available data to assess whether the food consumed provides too much energy, because we do not have accurate information about individual household members' food intake, body weight, and level of physical activity. Instead, we measure energy density, that is, the calories provided per gram of food available. Evidence suggests that consuming an energy-dense diet may contribute to excessive caloric intake and that, conversely, eating foods of low energy density may be a helpful strategy to reduce energy intake when trying to maintain or lose weight (U.S. Dietary Guidelines Advisory Committee 2004).

Several measures that have already been discussed are related to energy density. These include percent of energy provided by total fat and alcoholic beverages, as well as certain HEI-2005 components, including SoFAAS. We also base our measures on variables developed in past work targeted on the energy density concept such as Drewnowski and Specter (2004) and Ledwicke et al. (2005).

Assessing the energy density of combinations of foods—in this case, the mix of foods used from a household's food supply over the course of a week—is not straightforward. Ledwicke et al. (2005) compared eight different approaches to estimating the energy density of the total diet and concluded that estimates of energy density that include beverages other than water are meaningless because they overstate energy density for persons who use water as a major beverage. Dietary surveys (including the NFSPS) often do not collect information on water, thus Ledwicke et al. recommended against energy density measures that include beverages.

Following this recommendation and to remain consistent across data sets within this study, we estimate the energy density of household food supplies based on *foods only*. This includes all solid foods as well as soft foods and liquid items that are typically consumed as foods, such as soups, gelatin, and ice cream. All beverages are excluded, including liquid items that are typically consumed as beverages, such as milkshakes and liquid meal replacements. In addition to estimating energy density for the overall household food supply (all foods) in the NFSPS and the individual food intakes in the NHANES, we compute estimates for foods within specific food groups. For the NFSPS, these include fruits (excluding juices), vegetables, grains, meat and beans, mixed dishes, and sweets, salty snacks, and desserts. For all foods, we use food descriptions and USDA food codes (available after all foods in NFSPS are linked to the MPED) to identify the items that were excluded from energy density estimates. An identical set of food subgroups is used in the NHANES, with the addition of non-fluid milk products such as cheese and yogurt.

4. Nutrient Density

Consumption of nutrient-dense foods—those with a high nutrient contribution in relation to energy contribution—can help individuals meet nutrient requirements while maintaining their weight. The measures we use in assessing nutrient availability, as described above, are essentially measures of nutrient density (total nutrients available normalized by available calories). In addition, we create a composite measure of nutrient density that is based on the Naturally Nutrient Rich score described by Drewnowski (2005). The Naturally Nutrient Rich score is a nutrients-to-calories ratio

that considers nutrients commonly included in efforts to define healthy diets. As initially conceived, the Naturally Nutrient Rich score excludes fortified foods. However, it is difficult to implement this design feature in actual practice because most nutrient databases, including the one used in analyzing the NFSPS data, do not differentiate naturally occurring nutrients from those added during enrichment or fortification processes. Thus, our modified nutrient-rich score considers all nutrients in a given food, whether naturally occurring or added through fortification.

We estimate a nutrient-rich composite score that includes a total of 17 nutrients: all of the essential vitamins and minerals examined in the nutrient-availability analysis (vitamins A, B_6, B_{12}, C, and E, folate, calcium, iron, zinc, thiamin, riboflavin, niacin, magnesium, potassium, and phosphorus) plus fiber and protein. In addition, we estimate nutrient rich scores for foods within specific food groups such as vegetables, fruits, grains, milk, beverages other than milk or 100 percent juice, and mixed dishes. To compute nutrient-rich scores, following Drewnowski's basic approach, nutrients are first summed to the household or food group level and then normalized to a nutrient-per-2,000-calories measure. These normalized values are then compared to reference daily values (DV), which are based on the maximum RDA or Adequate Intake (AI) (excluding values for pregnant and lactating women) (Table II.4). The resulting percentages (percent DV) are then averaged across the 17 nutrients, with all nutrients receiving equal weight. Individual percent DV values are truncated at 2,000 percent DV before the average is computed across nutrients.[18] This limits the influence of large concentrations of a particular nutrient on the overall score.

Table II.4 Nutrients and Recommended Daily Values Used to Calculate Nutrient Rich Scores[a]

Nutrient	Value	Nutrient	Value
Calcium	1,300 mg	Vitamin A	1,000 μg RE
Folate	200 μg	Vitamin B_6	1.7 mg
Iron	18 mg	Vitamin B_{12}	2.4 μg
Magnesium	420 mg	Vitamin C	90 mg
Niacin	16 mg NE	Vitamin E	15 mg
Potassium	4.7 g	Zinc	11 mg
Riboflavin	1.3 mg	Fiber	38 g
Thiamin	1.2 mg	Protein	56 g
Phosphorus	1,250 mg		

[a]Daily values are based on maximum RDAs or AIs (calcium, magnesium, potassium, dietary fiber), excluding pregnant or lactating women. Values for vitamin A and folate are based on 1989 RDAs because the NFSPS data are not expressed in the units used in the Dietary Reference Intakes (DRIs).

Additional nutrients available in NHANES, but not in the NFSPS, such as the essential fatty acids linoleic acid and alpha-linolenic acid, were not added in order to maintain comparability between the scores from each data set. Thus, the nutrient-rich score is defined using a set of nutrients that are identical across the two data sets.

[18] Drenowski indicates this is a somewhat arbitrary level for truncation.

5. Food Shares

The food-shares measure captures the availability of foods in the household by major food group. For example, we examine differences in the use of fresh fruit versus fruit canned in heavy syrup, or whether a household's primary source of vegetables is from potatoes and starchy vegetables versus other types of vegetables. We develop versions of this measure using the NFSPS and NHANES data, as well as the CE-Diary data. Since the CE-Diary data contain records for all income levels as well as information about SNAP benefit receipt, we examine the food availability measure for SNAP participants, income-eligible nonparticipants, and income ineligibles.

Using the NFSPS data, we classify the foods into key groups: fruits and juices; vegetables; grains; milk, meats, and beans; mixed dishes; sweets and desserts; fats and oils; and salty snacks. We examine the food availability on the basis of cup or ounce equivalents per 1,000 calories available to the household.

6. Expenditure Shares

The CE-Diary data contain detailed seven-day consumer unit food expenses, by food category. The food availability measure is based on food expenditures in broad food groups such as foods recommended for frequent consumption, foods not recommended for frequent consumption, and other foods, and more specific food groups such as fresh fruits and vegetables, sweetened beverages, and grain and grain products. We define the broad food groups to include the following:[19]

- Foods Recommended for Frequent Consumption consists of fresh fruit, other fruits, fresh vegetables, and other vegetables.
- Foods Not Recommended for Frequent Consumption consists of sweetened beverages, salty snacks, fats and oils, baked desserts, other sweets, high-fat/sodium meats, high-fat dairy products, alcohol, and juices.
- Other Foods consists of grains and grain products; meats and meat alternatives; fish and shellfish; eggs, nuts, and seeds; dried beans and peas; milk and dairy products; coffee and tea; condiments and seasonings; and miscellaneous foods.

We measure food availability by tabulating the total expenses in each category as a fraction of the total food expenditures for the consumer unit. In addition, we have these data for consumer units at all income levels, allowing us to separate the households into those who receive SNAP benefits, those who may be income-eligible to receive benefits, and those who are not income-eligible.[20]

[19] See Appendix H for a complete listing of the foods included in each category.

[20] We identify consumer units with annual gross income under 130 percent of the annualized poverty threshold, that is, those who would likely be income-eligible for SNAP based on their 12-month income (after excluding SNAP benefits). The CE-Diary data do not contain information about household asset values, so we cannot reliably estimate a consumer unit's asset eligibility.

C. Strategies Used to Overcome Limitations of Measures and Data

A strength of our analysis is that we have the opportunity to present a range of measures using a number of different data sets, recognizing that no one measure is perfect nor is any one data set. In this section we discuss the most important issues that arise in the analysis for the range of measures and data sets and our strategies for addressing them.

1. Unit of Observation

Potentially the most important issue for policy relevance is the unit of observation in each data set. Household-level data, such as the NFSPS and, to an extent, the CE-Diary, are important to consider because SNAP is intended to affect the purchase of foods for household consumption. At the same time, it is important to recognize that the quality of the household food supply does not necessarily predict the quality of the diets consumed by individual household members. Many factors may influence the strength of this relationship. For example, individual household members may not eat all of the food available to them; they may eat more of some foods than others; and they likely vary in the proportion of their total daily intake provided by the household food supply. Thus, any positive association between food expenditures and diet quality that are observed in the analyses at the household level (or at the level of the consumer unit) do not necessarily translate into improvement in quality of individual dietary intakes.

It is not possible to disaggregate the NFSPS' household-level records to the individuals within the household, since foods used from the household food supply are recalled without specifying use by each household member. Similarly, while the individual is the unit of observation in the NHANES, it is not possible to aggregate the individual intake recalls to the household level, as not all household members are included in the intake interview. Thus, there is a discrepancy between SNAP unit and the observational unit contained in the NHANES data; we simply analyze the data according to the unit of observation in the data set.

2. Including Food Away from Home in Food Use Measure

The NFSPS collected detailed data on all foods used from the household food supply over the seven-day period prior to the interview. These include (1) all foods eaten at home, including foods from carryout places when the food was brought into the home; (2) foods prepared at home but eaten outside the home; and (3) plate waste, such as food that was prepared at home but thrown away or given to a pet. The NFSPS food consumption measure does not include leftovers, defined as foods prepared but not yet eaten, nor does it include food prepared and consumed away from home. Food consumption in the NHANES is measured quite differently, and includes all foods eaten in the 24-hour period on the day prior to the interview. Thus, food purchased and consumed away from home are included in the NHANES, but not in the NFSPS. The extent of nutritional differences in these foods compared to those prepared and consumed at home, may contribute to differences across surveys in the relationships between diet quality and food expenditure.

3. Food Use versus Dietary Intake

Whether measures of diet quality represent respondents' diets depends in large part on the survey technique. The NFSPS and CE-Diary assess food use, whereas the NHANES records dietary intake. Thus, in the NFSPS (and the CE-Diary) the nutrient measures do not necessarily reflect nutrients consumed by household members, because some food may have been wasted, fed to pets,

or shared with individuals outside the household. In converting the food use data into nutrient equivalents in the NFSPS, conversion factors were used to account for nutrient losses associated with preparation and cooking; therefore, to the extent possible, the nutrient data do represent the calories and nutrients that were available for consumption by household members. The dietary intake data in the NHANES do not suffer from these problems.

4. Recall Periods

The recall period also differs across the surveys. Food used by households in the NFSPS and food purchased by consumer units in the CE-Diary is recalled over a seven-day period and cannot be disaggregated separately for each of the seven days. For instance, if the NFSPS recall period is from Monday through Sunday, one cannot determine what food was used on Monday and what food was used on Friday. In the NHANES, food consumption is recalled over a 24-hour period. From a policy perspective, the seven-day period may provide a more precise measure of a respondent's "typical" food use patterns compared to a 24-hour measure, even though the latter provides a more detailed assessment of a respondent's intake.

5. Underreporting of SNAP Participants

It has been recognized for many years that there is significant underreporting of the receipt of assistance in general population surveys. This is not a problem for the NFSPS data set, since the sample for that survey was essentially drawn from a list frame of SNAP recipients. It is also not a substantial problem for the NHANES, where reported annual receipt is about 90 percent of administrative monthly totals.[21]

In the CE-Diary data, however, there is considerable underreporting, as shown in Table II.5 (see also Meyer et al. 2009). SNAP participation is identified based on reported receipt of SNAP benefits in the previous month. In using the CE-Diary data, underreporting of SNAP receipt can cause several problems. Most obvious is that to the extent the results of the analysis are weighted by the national CE-Diary weights, the resulting national estimates of the numbers of recipients in various groups will be biased downward. This by itself is not a serious difficulty for the current analysis, however, because key results are focused on associations between expenditures and types of foods purchased and not on size of the population.

Table II.5 SNAP Participants in the CE–Diary Versus Administrative Data

	Unit of Analysis	SNAP Participants
CE–Diary Data	Consumer Unit	5,462,862
USDA Program Data	SNAP Unit	11,197,377

A more serious problem, however, is that underreporting of SNAP receipt may tend to attenuate observed associations between SNAP participation and other variables of interest for the CE-Diary results. This is a problem in both the tabular and regression contexts. In a tabulation

[21] We identify SNAP participants in the NHANES based on the variable identify individuals who were authorized to receive benefits in the previous 12 months. The variable identifying current authorization for benefits contains a number of erroneous missing values. We follow the method used in Cole and Fox (2008).

comparing participants and nonparticipants, the fact that the "nonparticipants" actually include some participants means that the two groups being compared appear more similar than they really are. Similarly, in a regression context, the nonreporting problem reduces to an "errors in variables" problem affecting the size of the estimated parameter on SNAP variable. In either case, the resulting estimate of the true association is biased toward zero.

We include the CE-Diary results in the analysis because they are the most recent data available (for 2005) and they are a second data set that allows us to identify differences across participation and eligibility groups.

6. Food Group Categorization in the CE-Diary

To assess the relationship between food expenditures and diet quality in the CE-Diary data set, we use the food groups data available in the CE-Diary to sort foods into three broad groups: (1) foods recommended for frequent consumption in the *Dietary Guidelines for Americans* (fruits and vegetables), (2) foods recommended for infrequent consumption (including sweetened beverages, desserts and sweets, salty snacks, fats and oils, and high-fat/high-sodium meats), and (3) other foods (including grains and grain products, meats and meat alternatives, dairy products, coffee and tea, mixed dishes such as soups, and condiments and seasonings). Most foods fall into the last group because the existing food groups are not specific enough to distinguish between foods that would be recommended or not recommended for frequent consumption. For example, the CE-Diary food groups do not distinguish between whole, low-fat, and nonfat milks, delegating all types of milk to be grouped under "other foods." Because these foods cannot be appropriately categorized, it is not possible to definitively conclude that consumer units who spend more on food purchase healthier diets, even if the estimates for foods recommended for frequent consumption suggest this.

7. Interpreting Results

The goal of this research is to determine how diet quality and food expenditures are related for SNAP participant households and, more generally, among low-income individuals. However, all findings must be interpreted with caution. To the extent that we find positive relationships for SNAP participants, the relationship is not necessarily causal, due to selection bias. Furthermore, positive associations found using household-level data such as the NFSPS may not translate into improvement of quality in individual dietary intakes. Similarly, positive associations found using individual-level data such as the NHANES may not translate into improved household food use patterns, since individuals may be spending more on foods prepared and consumed away from home, which is not as relevant for the purposes of SNAP policy as are those either prepared or consumed at home.

It is also important to recognize that a failure to find a relationship between food expenditures and the quality of household food supplies does not necessarily prove that SNAP is powerless to improve dietary intake. Burstein et al. (2005) identified several factors that may affect the ability of the analysis to detect an effect, including: (1) small sample sizes; (2) measurement error (associated with collecting the food use data and translating these data into nutrient equivalents); and (3) sampling variability associated with the small samples of data on foods withdrawn from household supplies. These data characteristics may obscure the relationship between food expenditures and diet quality.

D. Analysis Methods

As described above, a wide range of dietary quality outcome variables drawn from multiple data sets are examined in this report. In this section, we describe the empirical methods used to conduct the analysis.

Our primary analysis relies on multivariate methods. Although each chapter begins with a descriptive, tabular analysis to provide a snapshot of the outcome measure for the full sample of SNAP participants (in the NFSPS) and low-income individuals (in the NHANES), we quickly move to the types of multivariate analysis described below. We do not perform a tabular analysis of expenditures and diet quality because it is limited in its ability to simultaneously control for multiple factors that may influence the dietary measures of interest, such as household size and composition.

In much of the work examining continuous outcome variables, we use Ordinary Least Squares (OLS) regression methods with dietary outcomes entered as the dependent variables. Similar approaches are used in analyzing effects on discrete diet quality measures, except in those cases logistic regression models replace the OLS framework. In certain analyses, such as food shares in the NFSPS and food expenditure shares in the CE-Diary data, there are dependent variables that have substantial numbers of observations clustered at zero. In these cases, we use an alternative, two-step estimator that adjusts for the clustering and produces unbiased estimates of model parameters. We describe these methods in detail below.

1. OLS Regression Models using the NFSPS Data

The multivariate analyses in the NFSPS consist of separately regressing each HEI-2005 indicator, nutrient availability indicator, and energy and nutrient density measure, on food expenditures and a set of household characteristics. These household characteristics include variables for: [22]

- Presence of multiple adults in the household (relative to having single adult heads)
- Presence of children in the household
- Presence of elderly in the household
- Race and ethnicity of household head
- Geographic region of household
- Urban, suburban, or rural location of household
- Indicator variables for a household's income relative to the federal poverty threshold

[22] We did not include measures of nutritional knowledge that are available in the NFSPS, including the food pyramid serving knowledge index, the fat content knowledge index, and the food group knowledge index, due to a large number of missing observations for these variables.

We also control for two additional variables related to diet quality and household composition:

- Proportion of meals eaten outside of the home
- The number of AMEs in the household

Together, these two variables represent the number of Equivalent Nutrient Units (ENUs) within a household and thus serve as an additional measure of household composition that is not accounted for in the diet quality measure or in the variables indicating the presence of married adults, children, or elderly members within the household. We include these two variables separately in order to isolate the association between ENU and diet quality into its components and to account for the variation in each of these components.

All analyses use population weights provided in the data to ensure that estimates are representative of the national population or subpopulation of interest.

2. Logistic Regression Models using the NFSPS Data

In cases in which the dependent variable is discrete, we use a logistic and multinomial logistic regression function. This applies to the nutrient availability measures in the NFSPS indicating whether the household meets nutritional standards or falls in a certain dietary range recommended by U.S. Dietary Guidelines.

3. OLS Regression Models using the NHANES Data

For most outcome measures, the multivariate analyses that use the NHANES data are similar to those that use the NFSPS. Several important differences, however, include the following:

- The unit of observation in the NHANES analyses is the individual, whereas in the NFSPS it is the household.
- In the NHANES, the set of independent variables other than food expenditures includes indicator variables for SNAP participation and eligibility. These variables were not included in the NFSPS analysis since the full NFSPS sample consisted of SNAP participants.
- In the NHANES, the set of independent variables other than food expenditures includes gender, age, race and ethnicity, education, marital status, and income-to-poverty. Several of these variables were also included in the NFSPS, but there they characterized the head of the household. Here, because the respondent is the individual and not the household, these variables represent the survey respondent. Furthermore, because the dietary intakes in the NHANES are at the individual level, we do not control for measures of household size such as the number of AMEs.

4. Tobit Regression Models using the NFSPS, NHANES, and CE-Diary Data

The food share measure based on the NFSPS and NHANES data and the food availability measure based on the CE-Diary data pose a significant methodological problem that prevents the production of unbiased estimates using an OLS model—a nontrivial portion do not have positive expenditures for some food groups. For example, Table II.6 shows the proportions of consumer units in the CE-Diary sample, for the full sample and for subsamples defined by SNAP participation

and eligibility group, with zero expenditures on the three broad food groups and the specific food groups. The estimates for the full sample range from 18 percent for fresh fruit to 96 percent for dried beans and peas. As expected, the sample proportions with zero expenditures are much lower for the three broad food groups, ranging from 5 percent to 18 percent. Estimating an ordinary least squares (OLS) model either using the full sample of units or using only those units with positive expenditures will bias the coefficient estimates of the model (Tobin 1958). To adapt the model to accommodate categories of expenditures in which a nontrivial proportion of units in the sample has no expenditures, we estimate a common "double-hurdle" model—the Tobit model—that separates the decision to purchase a type of food, such as fresh fruit, from the decision of how much of the type of food to purchase, given that the unit has decided to buy a positive amount.

Table II.6 Proportion of Zero Expenditures in CE-Diary Data, for Full Sample and by SNAP Participation and Eligibility Groups

	Full Sample	SNAP Participants	SNAP-Eligible Nonparticipants	SNAP-Ineligible Nonparticipants
Foods Recommended for Frequent Consumption				
All foods in this category	0.18	0.20	0.20	0.17
Fresh Fruit	0.18	0.49	0.46	0.41
Other Fruit	0.83	0.85	0.85	0.81
Fresh Vegetables	0.42	0.44	0.44	0.40
Other Vegetables	0.51	0.52	0.54	0.50
Dried Beans and Peas	0.96	0.93	0.96	0.96
Foods Not Recommended for Frequent Consumption				
All foods in this category	0.07	0.07	0.08	0.07
Sweetened Beverages	0.40	0.32	0.45	0.39
Baked Desserts	0.56	0.57	0.57	0.56
Other Sweets	0.51	0.46	0.54	0.51
Salty Snacks	0.61	0.61	0.66	0.59
High-Fat/Sodium Meats	0.55	0.51	0.58	0.54
High-Fat/Dairy	0.48	0.47	0.52	0.46
Fats and Oils	0.59	0.58	0.62	0.58
Alcohol	0.85	0.91	0.86	0.84
Juices	0.63	0.62	0.62	0.64
Other Foods				
All foods in this category	0.05	0.04	0.06	0.05
Grains and Grain Products	0.21	0.20	0.22	0.20
Meats and Meat Alternatives	0.38	0.34	0.40	0.37
Dairy Products	0.33	0.31	0.35	0.32
Eggs	0.63	0.58	0.64	0.63
Nuts and Seeds	0.84	0.86	0.85	0.83
Coffee and Tea	0.77	0.80	0.77	0.76
Mixed Dishes	0.59	0.58	0.64	0.58
Condiments and Seasoning	0.56	0.51	0.60	0.56
Miscellaneous	0.58	0.56	0.61	0.57
Sample Size (unweighted)	5,424	717	1,399	3,308

Note: Table entries are the proportions of consumer units that have zero expenditures on each food category.

5. Relationships between Diet Quality Measures and Expenditures

The functional forms of the dependent variables and key independent variables used in the empirical models differ across the diet quality measures examined. Because the choice of functional form may affect the study findings, we discuss the process by which we selected them and the implications they may have on model estimates in this section.

For many outcome measures used in OLS regressions, including nutrient availability, energy density, and nutrient density, we defined the dependent variable using natural logarithms of the measure. This was based on preliminary descriptive analyses that indicated the sample distributions of many measures were strongly skewed. In addition, using logarithms helps to reduce the risk of heteroscedasticity, adding greater validity to the assumptions behind the econometric model. Once the dependent variables were transformed, specification tests indicated that using the natural logarithm of expenditures as the main independent variable, rather than a non-transformed level of expenditures, resulted in an improved fit between the empirical model and the data. For outcome measures that could take the value of zero, the dependent variable was left as the non-transformed variable, but the specification tests continued to indicate improved model fit from transforming the expenditures using logarithms. This was true for the HEI-2005 scores; the relative contributions of specific foods to MyPyramid groups and other dietary components; and the shares of food expenditures spent on food categories.

Whether the dependent variable was log-transformed has strong implications for whether the association between diet quality and expenditures is assumed to be constant across different levels of expenditures. When the dependent variable is log-transformed, the association between the diet quality measure and expenditures is assumed (by the model) not to vary by expenditures. While this "constant elasticity" model is one of the most popular empirical models in applied economics, the homogeneity that is imposed, while providing an improved model fit and convenient for analytic purposes, may be viewed as restrictive. The main findings in the report for the log-transformed outcome measures are based on this model, but sensitivity analyses that re-estimate these models by expenditure subgroup are included in Appendix I. The sensitivity analyses in Appendix I show that the magnitude, and even the sign, of the association between diet quality and expenditures may differ by levels of expenditure. To maintain uniformity across outcome measures, for dependent variables that are not transformed using natural logarithms, we evaluate the elasticity at the mean of the outcome measure and treat that as a "constant" elasticity. In several cases, such as in Chapter III when we examined HEI-2005 scores, we also present the elasticities evaluated at values other than the mean of the outcome measure to show how the response to an increase in expenditures may differ across expenditure levels.

III. THE HEALTHY EATING INDEX–2005

The first measure of diet quality we use to identify associations between spending on food and diet quality for SNAP participant households and low-income individuals is the Healthy Eating Index-2005 (HEI-2005). As with each of the measures, we first provide some context and background for the measure. We then provide a description of HEI-2005 scores for SNAP participant households in the NFSPS, followed by a summary of findings from multivariate analyses that examined whether participant households that spend more on food have higher HEI-2005 scores. We then discuss the findings from the NHANES data in a similar sequence: an overview of HEI-2005 scores for the population as a whole and results of multivariate regressions that examine the relationship between diet cost and HEI-2005 scores.

A. The Measure

The MyPyramid food guidance system translates the 2005 *Dietary Guidelines for Americans* into simple messages about the types and amounts of food to consume in five major food groups (grains, vegetables, fruits, milk, and meat and beans) based on energy needs. MyPyramid also provides guidance about intakes of oils and discretionary calories. Recommended food intake patterns are provided for 12 different calorie levels (calorie needs are determined by gender, age, and activity level).

The HEI-2005 (Guenther et al. 2007) measures consumption of food and nutrients in relation to the 2005 *Dietary Guidelines for Americans* and the MyPyramid food guidance system (Table III.1) (USDA 2007). The index includes 12 component scores, as well as an overall score. Nine components are food-based and assess intakes of MyPyramid food groups and subgroups—total fruit; whole fruit; total vegetables; dark green vegetables, orange vegetables, and legumes; total grains; whole grains; milk; meats and beans; and oils. The remaining three components assess intakes of saturated fat, sodium, and calories from solid fat, alcohol, and added sugar (SoFAAS). Scoring criteria assign higher scores for greater consumption of food-based components, but lower scores for greater consumption of sodium, saturated fat, and SoFAAS. Maximum scores for each component range from 5 to 20.

The standards used in assigning component scores are energy-adjusted on a density basis (per 1,000 calories). This approach reflects the overarching recommendation that individuals should strive to meet food group and nutrient needs while maintaining energy balance (rather than meeting food group and nutrient recommendations simply by consuming large quantities of food). The per-1,000 calorie reference standards used in the HEI-2005 are based on the assumptions that underlie the recommended MyPyramid eating patterns, reflecting goals for intakes over time and the recommended mix of food groups.

Ideally, HEI-2005 scores are calculated based on *usual* dietary intakes of populations of interest (Guenther et al. 2007). One of our data sets, the NFSPS, provides a measure of household food use based on seven days of data, a period of time sufficient to represent usual food use at the household level. We have therefore calculated HEI-2005 scores for the NFSPS based on scoring at the household level.

Table III.1 The Healthy Eating Index-2005

Component	Healthy Eating Index-2005		
	Maximum Score	Standard for Maximum Score	Standard for Minimum Score of Zero
Total Fruit	5	≥ 0.8 cup per 1,000 kcal	No fruit
Whole Fruit (not juice)	5	≥ 0.4 cup per 1,000 kcal	No whole fruit
Total Vegetables	5	≥ 1.1 cup per 1,000 kcal	No vegetables
Dark Green and Orange Vegetables and Legumes[a]	5	≥ 0.4 cup per 1,000 kcal	No dark green or deep orange vegetables or legumes
Total Grains	5	≥ 3.0 oz per 1,000 kcal	No grains
Whole Grains	5	≥ 1.5 oz per 1,000 kcal	No whole grains
Milk[b]	10	≥ 1.3 cup per 1,000 kcal	No milk/dairy
Meat and Beans	10	≥ 2.5 oz per 1,000 kcal	No meat or beans
Oils[c]	10	≥ 12 gm per 1,000 kcal	No oil
Saturated Fat	10[d]	≤ 7% of total energy	≥ 15% of total energy
Sodium	10[d]	≤ 0.7 gm per 1,000 kcal	≥ 2.0 gm per 1,000 kcal
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	≤ 20% of total energy[e]	≥ 50% of total energy
Total Score	**100**		

Source: *Healthy Eating Index-2005*, U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, CNPP Fact Sheet No. 1, December 2006.

Note: With the exception of saturated fat and sodium, amounts between the minimum and maximum are scored proportionately.

[a]Legumes are counted as vegetables only after the standard for meat and beans is met.

[b]Includes all milk products, including fluid milks, yogurt, and cheese.

[c]Includes nonhydrogenated vegetable oils and oils in fish, nuts, and seeds.

[d]Saturated fat and sodium get a score of 8 for levels that reflect 2005 *Dietary Guidelines* recommendations: <10 percent of energy from saturated fat and 1.1 gm sodium per 1,000 kcal, respectively.

[e]The most generous allowance for discretionary calories in the MyPyramid food intake patterns (based on age, gender, and level of physical activity) is 20 percent of total energy.

In the NHANES data, however, the available data include only one 24-hour recall for most sample members, and thus cannot measure usual intake. Estimates of the distribution of intake based on one day of data, then, may be biased. In many applications where only one 24-hour recall is available for each sample member, the recommended approach is to compute HEI-2005 scores using population ratios (the ratio between the population's total intake of a food group or nutrient of interest and their total calorie intake) rather than using means of individual scores or means of individual ratios (Freedman et al. 2008). This convention is usually suggested largely because of two factors: (1) it reduces possible bias resulting from correlations between an individual's one-day food or nutrient to energy ratio and his or her energy intake, and (2) there is usually less score truncation in the HEI scoring system for the group-level HEI measure than in the mean of the individual-level HEI scores (Freedman et al. 2008).

However, in exploring the relationship between food expenditures and diet quality, there is a tradeoff between (a) using the HEI-2005 score estimator (e.g., population ratio or mean individual scores) that minimizes bias, and (b) using an estimator that can accommodate a multivariate

methodology which can best account for variation in demographic and economic characteristics that potentially affect both HEI scores and food expenditures.

The population ratio estimator precludes the use of regression analysis because there is a single score for all sample members. To control for variation in demographic and economic characteristics when determining the relationship between HEI scores and food expenditures, related studies have used a propensity score matching (PSM) algorithm to match individuals with high and low expenditures on a set of these characteristics. Indeed, we employ a similar approach in analyzing usual intake distributions in Appendix B. However, the comparison of means across matched samples reduces opportunities for assessing how key factors affect the dependent variables of interest. Also, it essentially ignores available information from the variation in food expenditures within both the high- and low-expenditure groups, thus reducing the power of the analysis, as compared to regressions.

In addition, we believe that bias may be less of a concern when the objective is to determine how the HEI-2005 scores are related to food expenditures, as compared to an objective of estimating HEI-2005 scores aimed at characterizing the full population. For example, estimated differences across the high- and low-expenditure groups in using population ratios may be very similar to differences estimated through regressions. Essentially, it is arguable that the bias largely cancels out (or "washes" out) when comparisons are being made. Most recommendations, such as that cited earlier, to use population means are based on examining population levels rather than comparing HEI scores across population groups, which is the focus of this study.

Finally, another factor that has influenced our choice of analysis method is the usefulness of using comparable methods across different lines of analysis. In particular, the regression approach has been the analytic techniques of choice in most other components of this report, and we believe that using it here achieves a useful symmetry.

B. Relationships Between Food Expenditures and HEI-2005 Scores

We find the following relationships between food expenditures and HEI-2005 scores. Some of the relationships differ across the two data sets used in the analysis and by SNAP participation and eligibility status, race/ethnicity, and age:

- SNAP participant households that spend more on food have a higher total HEI-2005 for foods used from their household food supply than those who spend less. That is, their food use compares better against the standards set in the 2005 *Dietary Guidelines for Americans*. This is also true for SNAP participants, when analyzing individual-level intake data.
- Low-income individuals (incomes less than 300 percent of poverty) with greater diet cost score higher on the HEI-2005 than those with lower diet costs. Their scores are higher for the total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, milk, meat and beans, oils, and sodium, but lower for total grains, whole grains, saturated fat, and calories from SoFAAS. This pattern is consistent for most subgroups of the population that we examined, including race and ethnicity and age.
- The associations with increased spending on food are similar to the whole population for race/ethnicity and age groups, with some exceptions: Hispanic individuals with higher diet costs consume a smaller percentage of milk and a higher percentage of

saturated fat than those with lower diet costs, in contrast to non-Hispanic white and black and individuals of other races. In addition, adults with higher diet costs consume more calories from SoFAAS than those with lower costs, in contrast to children and elderly individuals, who have no significant association between diet costs and calories from SoFAAS.

1. HEI-2005 Scores Among SNAP Participating Households

Table III.2 shows mean HEI-2005 scores for SNAP participant households in the NFSPS, expressed as total scores and as a percentage of the maximum possible scores. On average, SNAP households achieved 52 percent of the maximum score for the HEI-2005 overall. Mean scores for HEI-2005 components were highest for meat and beans (94.6 percent of maximum possible score) and total grains (83.1 percent). Scores for total vegetables and sodium were next highest, averaging 59.8 percent and 64.9 percent, respectively. Scores for total fruit and whole fruit were each 53.9 percent. Mean scores for all other components (dark green and orange vegetables and legumes, whole grains, healthy oils, saturated fat, and calories from SoFAAS) were less than 50 percent of the possible maximum. These data indicate substantial room for improvement in the quality of the foods used in SNAP households, as measured in the NFSPS. The two dietary components that were most problematic for SNAP households were whole grains and saturated fat. Mean scores for both of these components were less than 30 percent of the maximum score, indicating that the mix of foods used by SNAP households included substantially less whole grains and substantially more saturated fat than recommended.

Table III.2 Mean HEI-2005 Scores Among SNAP Households

Component	Maximum Possible Score	Mean Score	Mean Percentage of Possible Maximum
Total Fruit	5	2.70	53.9
Whole Fruit (not juice)	5	2.70	53.9
Total Vegetables	5	2.99	59.8
Dark Green and Orange Vegetables and Legumes	5	1.48	29.6
Total Grains	5	4.15	83.1
Whole Grains	5	0.95	19.1
Milk	10	5.21	42.3
Meat and Beans	10	9.46	94.6
Oils	10	4.90	49.0
Saturated Fat	10	2.64	26.4
Sodium	10	6.49	64.9
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	8.64	43.2
Total Score	**100**	**52.31**	**52.3**

Source: 1996 NFSPS data

2. Relationship Between Food Expenditures and HEI-2005 Scores Among SNAP Participant Households

a. Methodological Approach

To determine the association between food expenditures and average HEI-2005 scores for the mix of foods used from household food supplies over the course of a week, we estimate regressions in which the HEI-2005 score is the dependent variable and the natural logarithm of total food expenditures is the main independent variable. Dividing the regression coefficient on food expenditures by the mean HEI-2005 score allows us to measure the percentage increase in the HEI-2005 score associated with a one percent increase in total food expenditures. Because a one percent increase in expenditures is relatively small, when presenting figures or summary tables of the associations between expenditures and HEI-2005 scores, we multiply these coefficients by 10 so that they represent the change associated with a 10 percent increase in food expenditures. Given that the mean weekly food expenditure in the sample is equal to $59.13, a 10 percent increase is approximately equal to $5.91. Thus, a value of 0.33 in a figure or a summary table indicates that a $5.91 increase in food expenditures is associated with a 0.33 percent (less than one percent) increase in the household's HEI-2005 score for the mix of foods used.

The other explanatory variables in the regression model are listed in Table III.3. We present the full set of regression coefficients only for the analysis of scores on the total score of the HEI-2005 in order to list the variables that are included in the model. When presenting the results for the other component scores and for the total score, we focus only on the associations between food expenditures and mean scores. Data on the full set of regression coefficients can be found in the tables in Appendix C.

Table III.3 Multivariate Regression of HEI-2005 Total Score and Food Expenditures

Ln(total food expenditures)	1.705 *
Ln(adult male equivalents)	-2.25 *
Ln(proportion of meals consumed away from home)	1.38
Multiple adult heads of household (referent category is "single adult head of household")	0.16
One or more children in household (referent category is "no children in household")	2.19
One or more elderly adult in household (referent category is "no elderly in household")	3.99 **
Race (referent category is "White, non-Hispanic")	
Black, non-Hispanic	-2.66 **
Hispanic	7.43 **
Other	5.63 *
Geographic Residence (referent category is "Western")	
Northeast	0.55
Mid-Atlantic	-4.39 **
Midwest	-4.20 **
Southeast	-3.88 *
Southwest	-0.93
Mountain Plains	-6.06 **
Household Location (referent category is "rural")	
Urban	1.73
Suburban	0.70
Income to Poverty Ratio (referent category is "less than 1.0")	
1.0-1.3	0.79
Above 1.3	2.01
Constant	46.22 **

Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

b. Estimates of the Association between Food Expenditures and HEI-2005 Scores

SNAP households that spend more on food had higher total HEI-2005 scores than SNAP households that spend less on food. This is shown in the regression results in Table III.3. Food expenditures are positively associated with scores, with a 10 percent increase in expenditures associated with a 0.33 percent increase in the total HEI-2005 score.[23] For a household with the mean score of 52.31, this translates into an increase of 0.17 HEI-2005 points.[24]

[23] The percent increase of 0.33 is calculated as the coefficient divided by the mean score multiplied by 10, That is, $0.33 \approx (1.705/52.31)*10$.

[24] The increase in the total HEI-2005 score is calculated as the mean score times the percentage increase. That is $0.17 \approx 52.31*(0.33/100)$.

We do not have a strong basis for determining whether the magnitude of this increase is small or large on a conceptual basis, though relative to the variation of the HEI-2005 scores in the sample, it appears to be small.[25] Of course, the size of the effect is intrinsically related to the increase in expenditures in that a larger increase in expenditures of 20 or 30 percent may result in a larger increase in HEI-2005 points, though the increase may not be proportional.[26]

The coefficients in Table III.3 show that there was a significant and negative association between total scores and the number of adult male equivalents in the household, and a positive association between the total score and the presence of one or more elderly adults in the household. Higher scores are also associated with being black, non-Hispanic; Hispanic; or another rate; compared to non-Hispanic and white. In addition, households residing in the Mid-Atlantic, Midwest, Southeast, or Mountain Plains Regions had significantly lower total scores relative to households in the West Region.

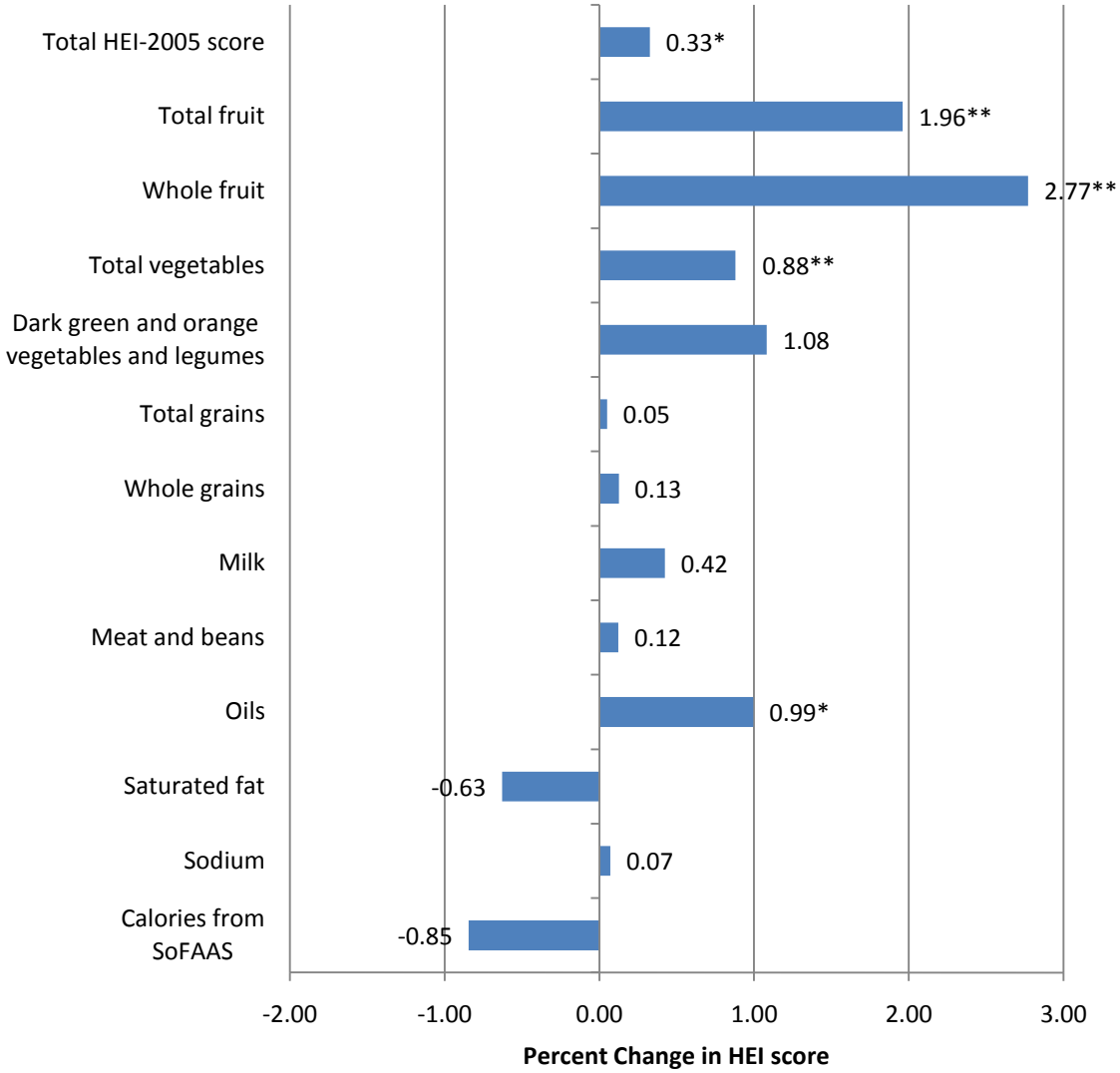
Figure III.1 presents the associations between food expenditures and HEI-2005 scores. The figure shows the percentage change in each score that corresponds to a 10 percent increase in food expenditures. The magnitude of the associations between change in HEI-2005 scores and a 10 percent increase in food expenditures range from -0.85 percent for calories from SoFAAS to 2.77 percent for whole fruit. The association between increased food expenditures and HEI-2005 scores was significant for total fruit, whole fruit, total vegetables, and oils components. In all cases, the association was positive; indicating that increased expenditures was associated with higher HEI-2005 component scores. As noted previously, the magnitudes of the associations are small relative to the variation of the HEI-2005 scores in the sample.

The associations in Figure III.1 measure the change in HEI-2005 scores from a 10 percent increase in expenditures for the household with the mean HEI-2005 score in the sample. However, the empirical model allows this association to differ across households with different HEI-2005 scores. The associations evaluated at the 25th, 50th, and 75th percentiles of the HEI-2005 score distribution (corresponding to scores of 43.4, 51.8, and 60.2) are 0.39 percent, 0.33 percent, and 0.28 percent. They do not differ greatly from the association evaluated at the mean (equal to 0.33 percent).

[25] This is based on the ratio of the increase in the mean HEI-2005 score in the sample to the standard deviation of the HEI-2005 score distribution.

[26] Sensitivity analyses examining differences in the association between expenditures and HEI-2005 scores by expenditure subgroup are presented in Appendix I. Though statistically insignificant at conventional levels, the associations are found to be inversely related to expenditures, with a positive association found among the lower expenditure subgroup and a negative association found among the higher expenditure subgroup.

Figure III.1 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Food Expenditures Among SNAP Households



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

3. Diet Cost and HEI-2005 Scores Among Low-Income Individuals

In this section, we present results from analyses that used data from the NHANES 2001-2004 to investigate the relationship between food expenditures and diet quality, as measured through the HEI-2005. As noted previously, our measure of "food expenditures" is approximated based on the costs of the foods consumed by each individual in a 24-hour period. Thus, we use the term "diet cost" rather than food expenditures. The sample used in this analysis is limited to individuals with incomes below 300 percent of the federal poverty level. We begin by describing mean HEI-2005 scores for the low-income population overall. Next, we turn to results of multivariate regressions that explore the relationship between diet cost and HEI-2005 scores. In addition to examining key relationships for the NHANES sample as a whole, we also examine the relationship among three

main subgroups (SNAP participants, income-eligible nonparticipants, and income-ineligible nonparticipants). In addition, we explore whether the relationship differs by age or gender.

a. Mean HEI-2005 Scores Among Low-Income Individuals

Table III.4 shows mean HEI-2005 scores for low-income individuals in the NHANES 2001-2004, expressed as total scores and as a percentage of the maximum possible scores. On average, low-income individuals achieved roughly half of the maximum score for the HEI-2005 overall. Scores were highest for total grains and meat and beans (100.0 percent of the possible maximum), indicating that the relative concentration of these food groups in the diets consumed by low-income individuals met HEI-2005 standards.

Among other components, scores for oils, total vegetables, saturated fat, milk, whole fruit, and total fruit were next highest, equivalent to 58 to 68 percent of the relative maximums. Scores for the other components (sodium, calories from SoFAAS, dark green and orange vegetables and legumes, and whole grains) were less than 50 percent of the possible maximum. These data indicate substantial room for improvement in the quality of diets consumed by low-income individuals.

Table III.4 Mean HEI-2005 Scores among Low-Income Individuals

Component	Maximum Possible Score	Mean Score	Mean Percentage of Possible Maximum
Total Fruit	5	2.90	58.00
Whole Fruit (not juice)	5	3.00	60.00
Total Vegetables	5	3.10	62.00
Dark Green and Orange Vegetables and Legumes	5	1.20	24.00
Total Grains	5	5.00	100.00
Whole Grains	5	0.90	18.00
Milk	10	6.20	62.00
Meat and Beans	10	10.00	100.00
Oils	10	6.80	68.00
Saturated Fat	10	6.20	62.00
Sodium	10	4.20	42.00
Calories from Solid Fat, Alcohol, and Added Sugar (SoFAAS)	20	7.30	36.50
Total Score	**100**	**56.60**	**56.60**

Source: 2001–2004 NHANES data

b. Methodological Approach to Assessing Relationship between Diet Cost and HEI-2005 Scores

The empirical framework is largely the same as that used in the NFSPS analysis. We estimate coefficients of regression models in which the natural logarithm of each HEI-2005 component score is the dependent variable and the natural logarithm of total diet cost is the main independent variable. As in the preceding NFSPS analysis, we multiply the regression coefficient on diet cost by 10 so that the coefficient represents the change in HEI-2005 score associated with a 10 percent increase in diet cost, which is approximately $0.43 per day for the average individual in the

NHANES sample (mean diet cost is $4.28). For example, a coefficient of -0.50 indicates that a $0.43 increase in diet cost is associated with a 0.50 percent decrease (less than one percentage point) in the HEI-2005 component score.

The set of explanatory variables in the regression model differs from the NFSPS analysis, in part because the unit of observation is the individual rather than the household. Variables included in the model consist of SNAP participation and eligibility status, gender, age, race and ethnicity, education, marital status, and income. The regression using the full sample of low-income individuals (income less than 300 percent of poverty) includes the full set of demographic and economic variables. We also estimate regressions using subsamples defined by each of these variables, such as male and female subgroups for gender. When presenting these results, we focus only on the associations between diet cost and HEI-2005 scores and exclude the remaining regression coefficients from the tables and figures. These coefficients can be found in the tables in Appendix C.

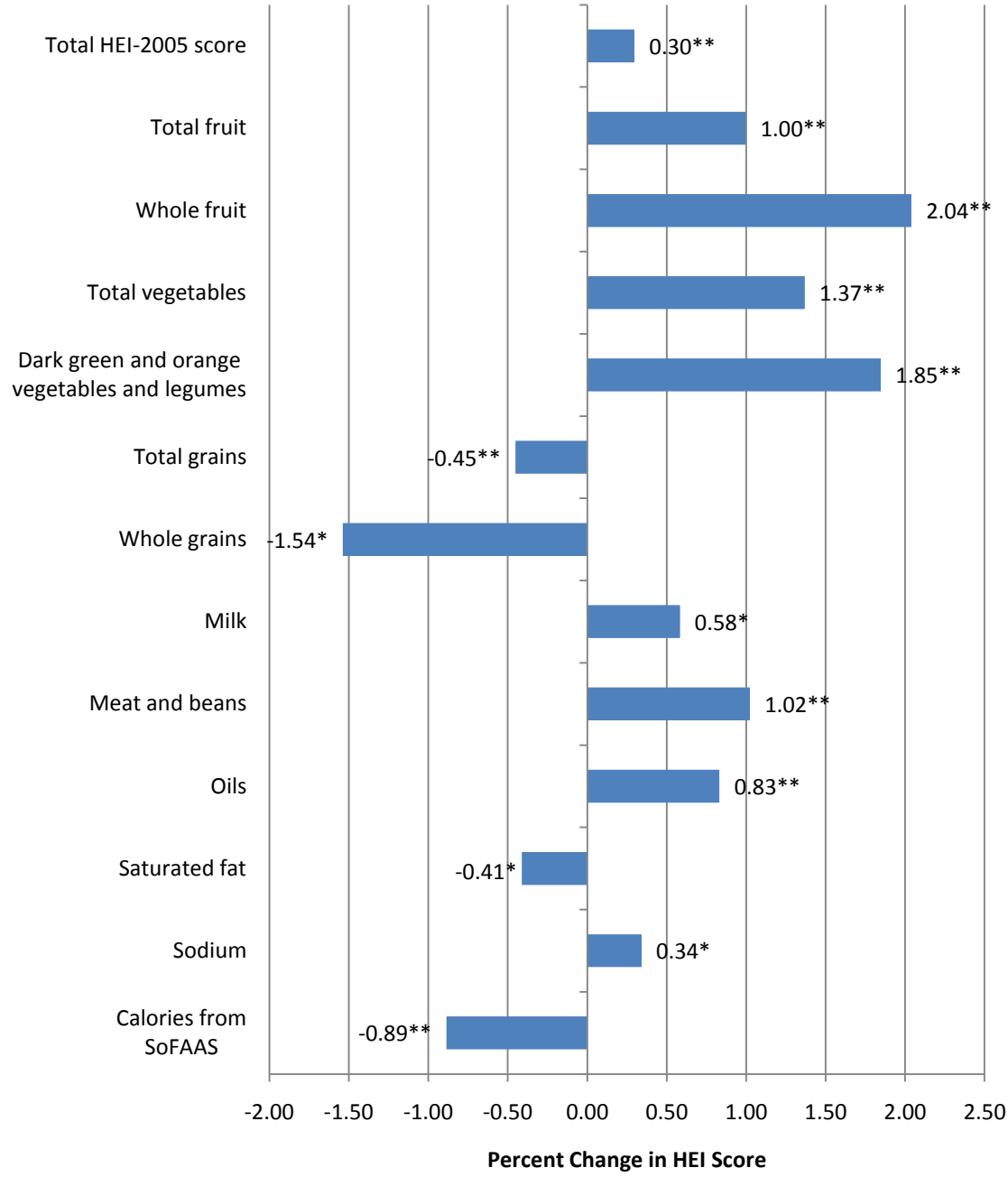
c. Estimates of the Association between Diet Cost and HEI-2005 Scores among Low-Income Individuals

Low-income individuals with higher diet cost had significantly higher HEI-2005 scores, overall, as well as significantly higher scores for many components, but not total grains, whole grains, saturated fat, and calories from SoFAAS (Figure III.2). For these components, the association between diet cost and HEI-2005 scores was significant and negative. The figure shows the percentage change in each score that corresponds to a 10 percent increase in diet cost. The magnitudes of the associations between changes in HEI-2005 scores and a 10 percent increase in diet cost range from -1.54 percent for whole grains to 2.04 percent for total fruit. As noted in the preceding analysis of NFSPS data, the magnitude of the associations are small relative to the variation of the HEI-2005 scores in the sample. The absolute change in mean scores ranged from a low of -0.02 points for saturated fat to 0.08 points for meat and beans and calories from SoFAAS. For the total HEI-2005 score, a 10 percent increase in diet cost was associated with an increase of 0.17 points.[27]

The associations in Figure III.2 measure the change in HEI-2005 scores from a 10 percent increase in diet cost for the household with the mean HEI-2005 score in the sample. However, evaluating the associations at the 25th, 50th, and 75th percentiles of the HEI-2005 score distribution (corresponding to scores of 39.1, 48.6, 59.1) are 0.38 percent, 0.31 percent, and 0.25 percent. As with the NFSPS, they do not differ greatly from the association evaluated at the mean HEI-2005 score (equal to 0.30 percent).

[27] Sensitivity analyses examining differences in the association between diet cost and HEI-2005 scores by diet cost subgroup are presented in Appendix I. The associations are found to be inversely related to diet cost, with the largest positive association found among the lowest diet cost subgroup and the largest negative association found among the highest diet cost subgroup.

Figure III.2 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Diet Cost among Low-Income Individuals



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.

d. Estimates of the Association between Diet Cost HEI-2005 Scores for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

The relationships between diet cost and HEI-2005 scores observed among subgroups of SNAP participants and nonparticipants generally mirror the patterns observed for the low-income

population overall. However, among SNAP participants, there is no statistically significant relationship between diet cost and HEI-2005 scores for dark green and orange vegetables and legumes, total grains, whole grains, saturated fat, sodium, or calories from SoFAAS (Figure III.3). Among eligible nonparticipants, the same is true for HEI-2005 scores for dark green and orange vegetables and legumes, whole grains, oils, and saturated fat. Among ineligible nonparticipants, there is no statistically significant association between diet cost and HEI-2005 scores for milk, saturated fat, sodium, calories from SOFAAS, and the HEI-2005 total score.

Although the NFSPS and NHANES are different both in their measures of food (seven-day food use versus 24-hour intakes) and the measures of costs (average weekly costs versus 24-hour expenditures), the results for SNAP participants from NHANES align well with the results from the NFSPS data. In all cases the associations are small, relative to the variation of the HEI-2005 scores in the samples, but the NHANES associations tend to be slightly larger. For example, for SNAP participants, the NFSPS shows a 0.33 percent increase in total HEI-2005 score associated with a 10 percent increase in weekly expenditures, while the NHANES shows a 0.58 percent increase associated with a 10 percent increase in one-day diet costs. Both data sets show larger percentage increases for the total fruit (1.96 and 1.26 percent in NFSPS and NHANES, respectively) and total vegetable components (0.88 and 1.18 percent for NFSPS and NHANES, respectively) and even larger differences for the whole fruit component (2.77 and 3.10 percent for NFSPS and NHANES, respectively) than for other components. Milk and meat and beans are significantly associated with diet costs for SNAP participants in the NHANES data, but not in the NFSPS data.

While the analyses based on the NFSPS and NHANES are similar, several important differences between the two data sets warrant caution in comparing results. First, the unit of observation is the household in the NFSPS and the individual in the NHANES. Second, the recall period is seven days for food use in the NFSPS and one day for food consumption in the NHANES. Third, the NFSPS data were obtained in 1996, whereas the NHANES data are from 2001-2004.

It is difficult to identify how these differences might affect the results. For example, the household more closely resembles a SNAP unit, providing a more appropriate context with which to evaluate the expenditure/diet quality association among SNAP participants. However, having the household as the unit of analysis may also weaken the ability to obtain an estimate of this association that is not dependent on other factors such as household composition.[28] In addition, the complicated system relating household and individual consumption preferences, budget decisions, nutrition knowledge, food prices, and food purchase locations may have been altered by changing economic conditions, public policy, and cultural norms between the 1996 and 2001-2004 survey periods. These differences should be considered when synthesizing results from the two sets of analyses.

[28] To address possibility of an "omitted variables" problem related to household composition, we included several measures related to the presence of multiple adults, children, and elderly members of the household and also accounted for differences across households in the number of AMEs.

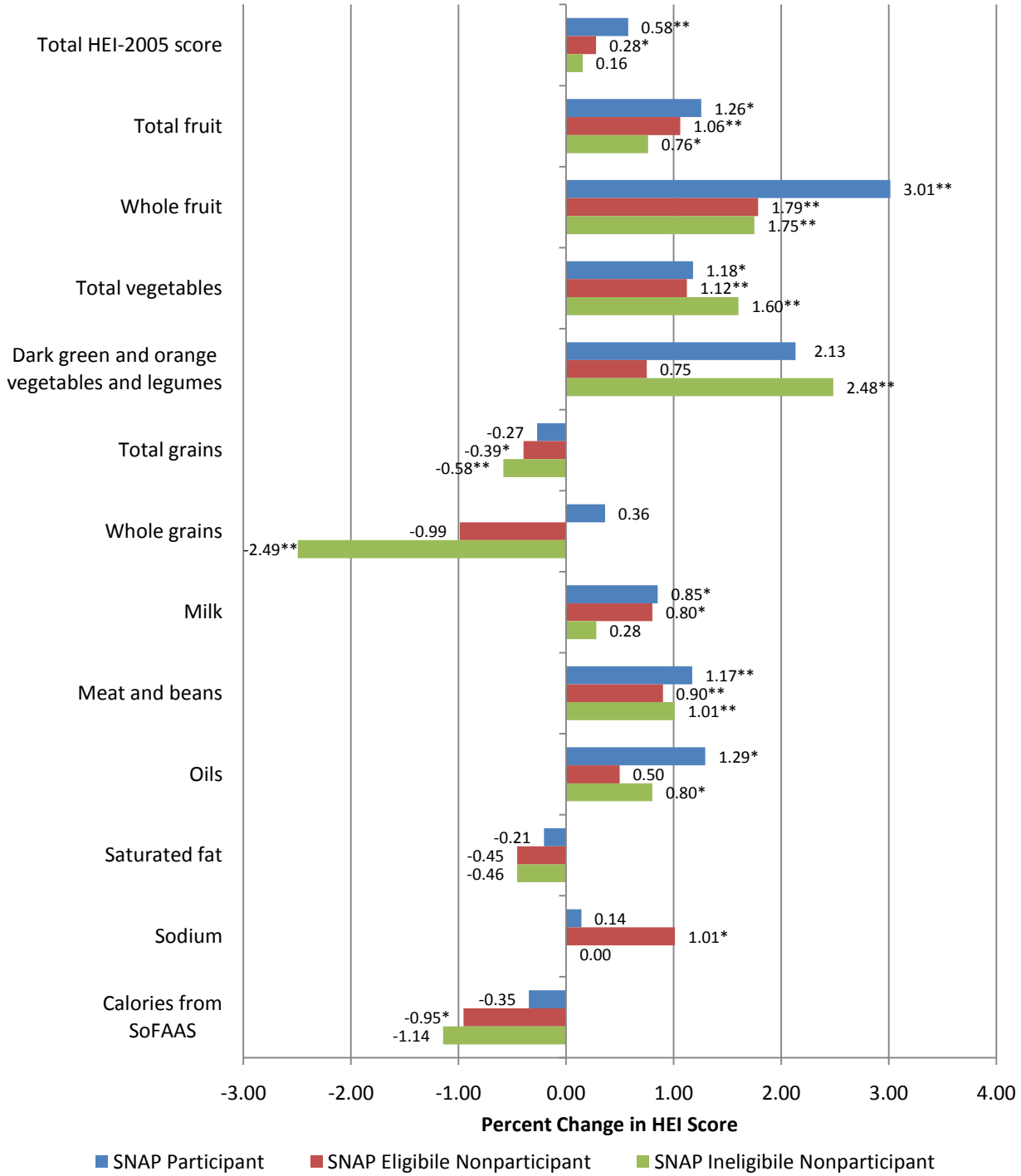
e. Estimates of the Association between Diet Cost HEI-2005 Scores for Race/Ethnicity and Age Subgroups

In this section we present the NHANES results for the regression used in the previous analysis estimated for subgroups defined by race/ethnicity (Figures III.4 and III.5) and age (Figure III.6).

The relationships observed between diet cost and HEI-2005 scores for racial/ethnic subgroups generally mirror the patterns observed for the low-income population overall. However, there are several differences for Hispanics and those in the "other" racial/ethnic group, compared with non-Hispanic whites and blacks. Specifically, among Hispanics and those in the "other" racial/ethnic group, there was no significant relationship between diet cost and HEI-2005 scores for dark green and orange vegetables and legumes, total grains, or milk. Among non-Hispanic whites and blacks, increased diet cost was associated with a significant increase in scores for dark green and orange vegetables and legumes and milk and with a significant decrease in the score for total grains. In addition, among those in the "other" racial/ethnic group, there was no significant association between increased diet cost and HEI-2005 scores for oils or calories from SoFAAS. In most other groups, there was a significant and positive association between diet cost and the HEI-2005 score for oils and a significant and negative association between diet cost and scores for calories from SoFAAS.

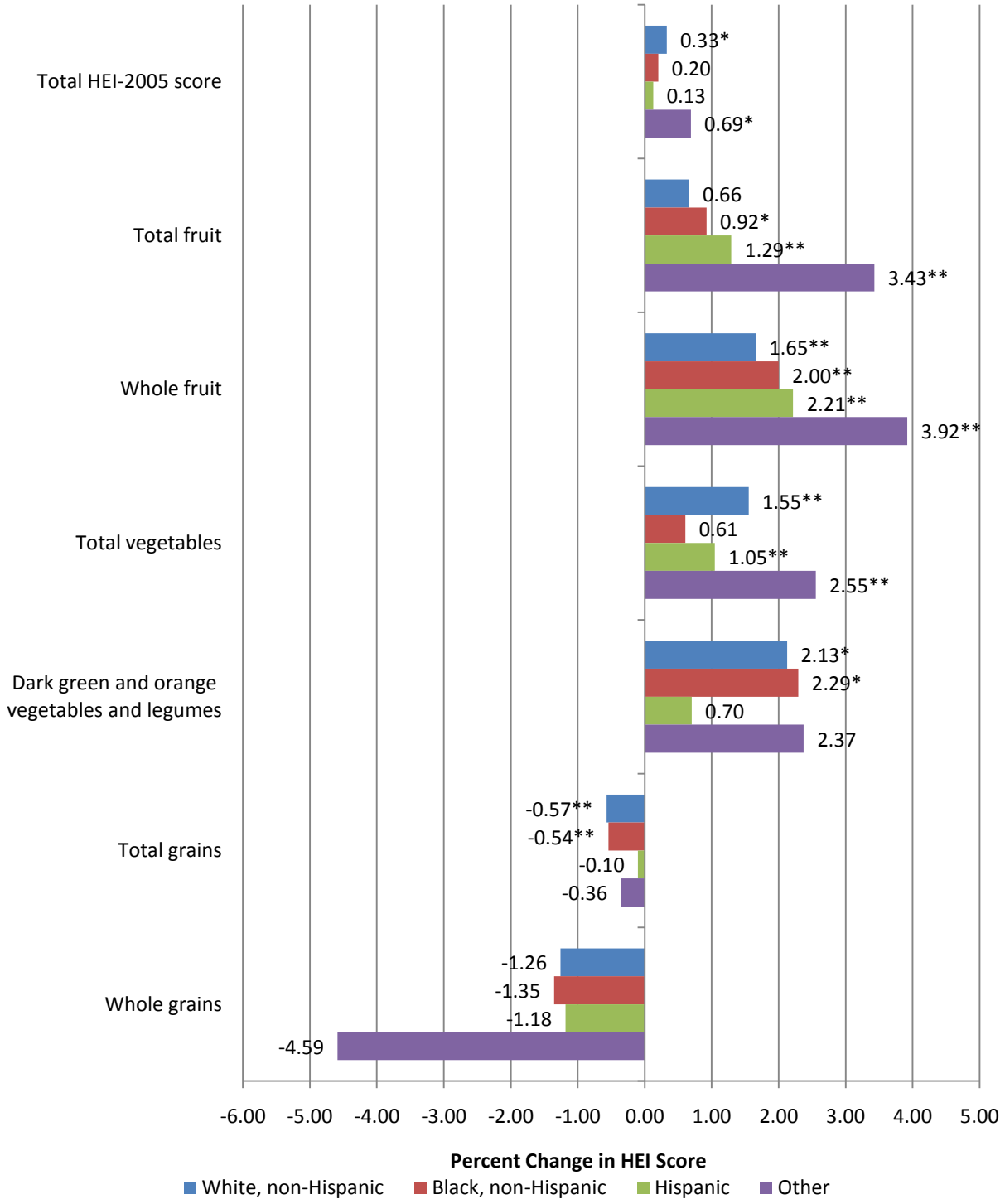
Figure III.6 presents results for three age subgroups (children ages 0 to 17, adults ages 18 to 59, and older adults ages 60 and up) The observed relationship between diet cost and HEI-2005 scores was very consistent across age groups, though the associations remain small relative to variation in the scores in the sample. Exceptions include the following: (1) among older adults, there was no statistically significant relationship between diet cost and HEI-2005 scores for dark green and orange vegetables and legumes or milk; (2) among adults, there were significant relationships between diet cost and HEI-2005 scores for saturated fat and calories from SoFAAS, but not for total grains; and (3) among children, there was no significant relationship between diet cost and HEI-2005 scores for oils.

Figure III.3 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Diet Cost among SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants



Source: 2001–2004 NHANES appended with price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure III.4 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Diet Cost among Low-Income Individuals, by Race/Ethnicity, for Total Score, Fruit, Vegetables, Legumes, and Grains

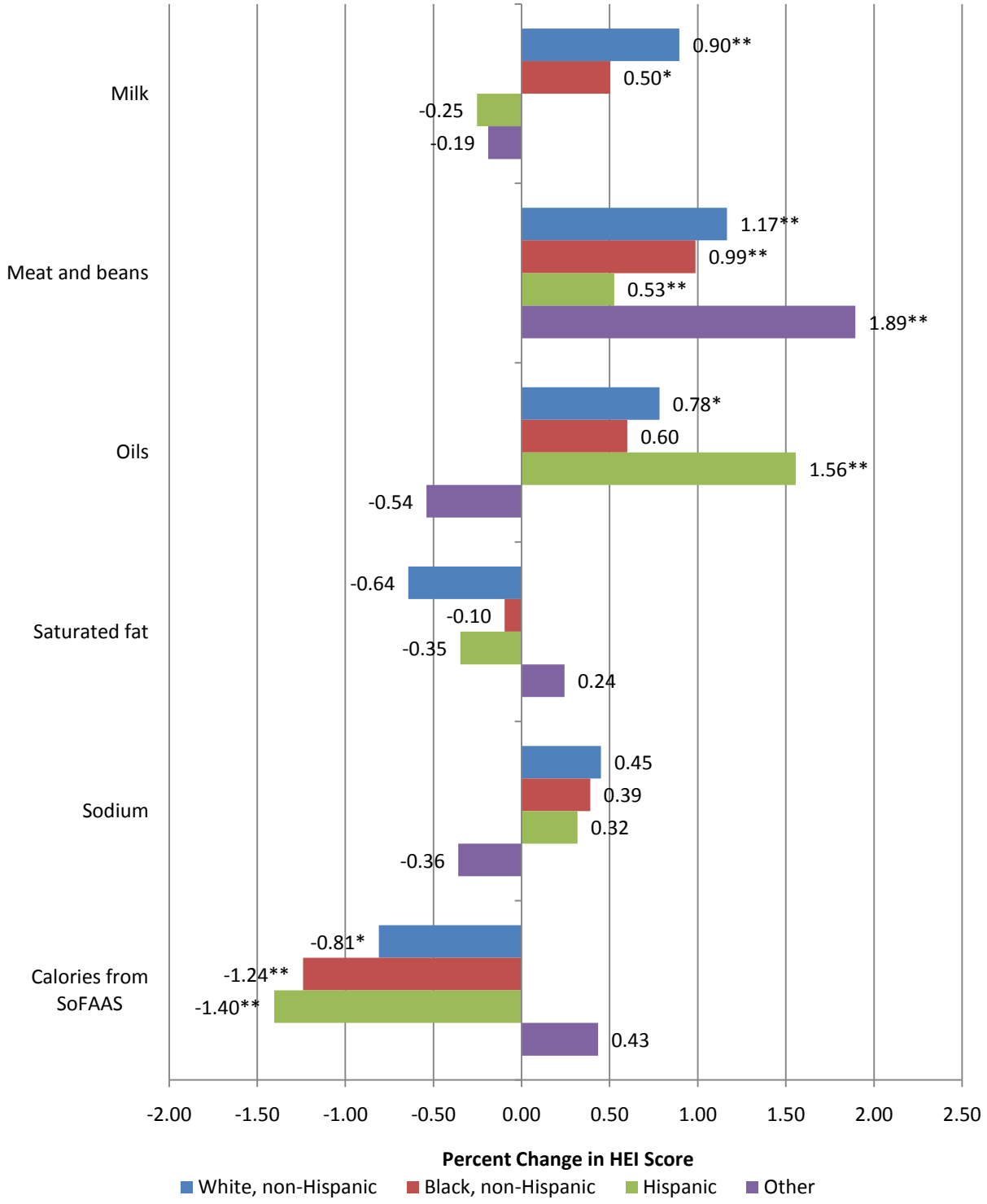


Source: 2001-2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

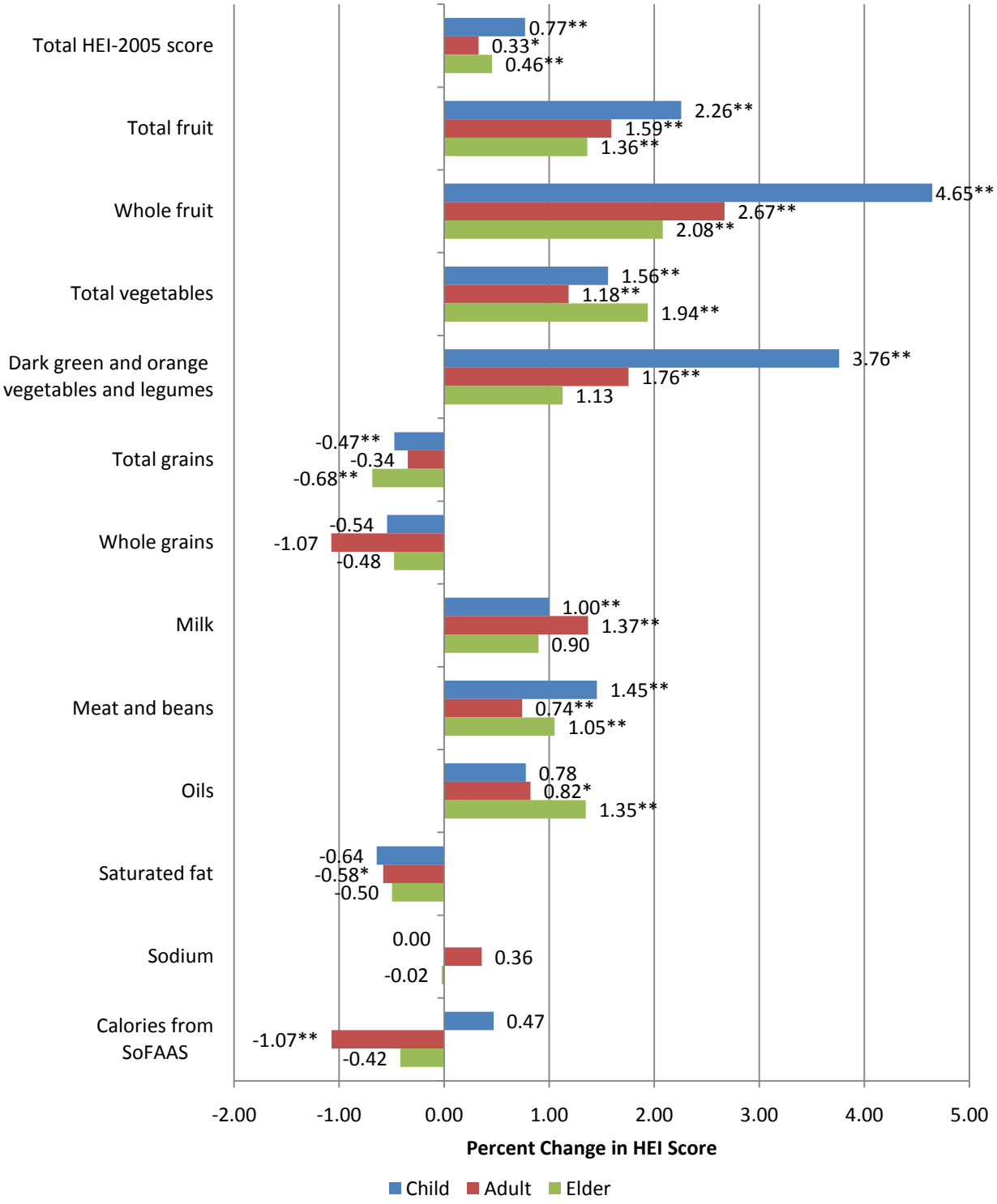
Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure III.5 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Diet Cost Among Low-Income Individuals, by Race/Ethnicity, for Milk, Meat and Beans, Oils, Saturated fat, Sodium, and Calories from SoFAAS



Source: 2001-2004 NHANES appended with price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure III.6 Percentage Change in HEI-2005 Scores Associated with a 10 Percent Increase in Diet Cost among Low-Income Individuals, by Age



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.

This page has been intentionally left blank for double-sided copying.

IV. NUTRIENT AVAILABILITY

A key finding of the analysis of the 1996 NFSPS was the strong positive association between the level of SNAP benefits and nutrient availability among participating households. Nutrient availability is a measure of households' food use (as opposed to food eaten) and focuses on the home food supply, which consists of the foods SNAP strives to influence (Cohen et al. 1999).

In this chapter, we examine whether spending more on food is associated with greater household nutrient availability. We define the availability of nutrients as the total amount of essential vitamins, minerals, fiber, macronutrients (total fat, saturated fat, carbohydrate, and protein) and cholesterol contained in the mix of foods used in the household food supply per 1,000 calories (in the NFSPS) and contained in the mix of foods consumed per 1,000 calories (in the NHANES). Using regression analysis, we estimate the association between total food expenditures and the nutrient availability of foods used by a household in the NFSPS and the association between the diet cost (the value of food consumed) and the nutrient availability of foods consumed by an individual in the NHANES. All analyses take into account differences in demographic and economic characteristics. We also determine whether these relationships differ across subgroups defined by these characteristics.

We find the following relationships between food expenditures and the nutrient availability of foods used in the NFSPS and between diet cost and the nutrient density of foods consumed in the NHANES. Many of these relationships differ by several demographic and economic characteristics, including SNAP participation and eligibility status, age, and education. Overall, the magnitudes of these relationships are small relative to the variation in nutrient availability across individuals and households in the samples.

- SNAP participant households that spend more on food use foods significantly greater in the availability of many vitamins and minerals, including vitamins A, B_6, B_{12}, C, E, folate, calcium, iron, and potassium. We found no relationships between expenditures and the availability of macronutrients, such as protein, carbohydrates, saturated fat, and total fat per 1,000 calories. At the individual level, SNAP participants with greater diet cost consume foods with greater amounts of vitamins B_6, B_{12}, C, and E, niacin, zinc, and potassium per 1,000 calories. However, they consume foods with lower amounts of folate, riboflavin, and thiamin per 1,000 calories. For macronutrients and other components, SNAP participants with greater diet cost consume foods with greater percentages of total energy from saturated, monounsaturated, and polyunsaturated fat; linolenic acid; and protein and foods with smaller percentages of total energy from carbohydrates.
- Low-income individuals (income less than 300 percent of poverty) with greater diet cost consume foods with greater amounts of vitamins A, B_6, B_{12}, E, C, and niacin and smaller amounts of folate, riboflavin, and thiamin per 1,000 calories. The foods they consume are also greater in the availability of magnesium, zinc, potassium, and sodium and lower in the availability of iron per 1,000 calories. Finally, low-income individuals with greater diet cost consume foods with greater percentages of total energy from total fat; saturated, monounsaturated, and polyunsaturated fat; linoleic acid; protein; and cholesterol and foods with smaller percentages of total energy from carbohydrates and fiber.

- Children and adults with greater diet cost consume foods with greater amounts of calcium per 1,000 calories. Children are also the only age group for which having a higher-cost diet is not associated with lower amounts of iron per 1,000 calories of food consumed. Finally, children and adults with greater diet cost consume greater amounts of sodium per 1,000 calories.

The chapter begins with a description of the nutrient availability of foods used by SNAP participant households using the NFSPS. Next, we examine whether households that spend more on food use foods with greater availability of nutrients. To obtain a more comprehensive picture of this relationship among low income individuals, we then present results from a similar analysis of diet cost and nutrient availability using the NHANES. We also explore whether this relationship exists for subgroups defined by demographic and economic characteristics.

A. Nutrient Availability of Foods Used by SNAP Participant Households

Table IV.1 contains the mean values of nutrient availability for vitamins, minerals, and macronutrients used by SNAP participant households as reported in the NFSPS.

Table IV.1 Mean Availability of Vitamins, Minerals, and Macronutrients for SNAP Participants (Units per 1,000 calories)

Vitamins	
Vitamin A	527 mg RE
Vitamin B_6	0.9 mg
Vitamin B_{12}	2.7 mcg
Vitamin E	4 mg
Folate	122 mcg
Niacin	10.6 mg
Riboflavin	0.9 mg
Thiamin	0.8 mg
Vitamin C	52 mg
Minerals	
Calcium	371 mg
Iron	7.1 mg
Magnesium	117 mg
Phosphorus	590 mg
Zinc	5.3 mg
Potassium	1,206 mg
Sodium	1,303 mg
Other Food Components	
Fiber	6.3 g
Macronutrients[a]	
Protein	15.1 percent
Carbohydrate	45.4 percent
Saturated Fat	14.3 percent
Total Fat	40.4 percent
Sample Size	957

Source: 1996 NFSPS data

[a]Expressed as percentage of total available calories.

B. Food Expenditures and Nutrient Availability Among SNAP Participant Households

1. Methodological Approach

To determine the association between food expenditures and the average availability of nutrients per 1,000 calories households use, we estimate regressions in which the natural logarithm of the amount of nutrients used per 1,000 calories is the dependent variable and the natural logarithm of total food expenditures is the main independent variable. By taking logarithmic transformations of both variables, the regression coefficient on food expenditures measures the percent change in nutrient availability associated with a one percent increase in total food expenditures.[29] Because a one percent increase in expenditures is relatively small, when presenting figures or summary tables of the associations between expenditures and nutrient availability, we multiply these coefficients by 10 so that they represent the change in nutrient availability associated with a 10 percent increase in food expenditures. Given that the mean amount of food expenditures in the sample is equal to $59.13, a 10 percent increase is approximately equal to $5.91. Thus, a coefficient of 0.65 in a figure or a summary table indicates that a $5.91 increase in food expenditures is associated with a 0.65 percent increase (less than one percentage point) in the average nutrient availability of the mix of foods used.

Table IV.2 lists the independent variables included in each regression. We present the full set of regression coefficients only for the analysis of Vitamin A in order to show the reader what variables are included in the model. When presenting the results for the other vitamins, minerals, and macronutrients, we focus only on the associations between food expenditures and nutrient availability and exclude the remaining coefficients from the tables and figures. These coefficients can be found in the tables in Appendix D.

2. Estimates of the Association Between Food Expenditures and Nutrient Availability

SNAP participants that spend more on food use foods with greater amounts of vitamin A per 1,000 calories. This is shown in the regression results in Table IV.2. Food expenditures are positively associated with the availability of vitamin A per 1,000 calories, with a 10 percent increase in expenditures associated with a 1.67 percent increase in the mean amount of Vitamin A per 1,000 calories used. This suggests that the foods used by higher expenditure households provide a higher concentration of vitamin A per 1,000 calories used than foods used by lower expenditure households. Because demographic and economic characteristics, such as measures of household composition and income are included in the regression, the estimated association between expenditures and the availability of vitamin A cannot be attributed to differences in these characteristics across households.

The coefficients for the demographic and economic characteristic variables in Table IV.2 show how mean amounts of vitamin A per 1,000 calories differ across households. The availability of vitamin A is lower for larger households (as measured by the natural logarithm of the number of

[29] It also helps to reduce the risk of heteroscedasticity, adding greater validity to the assumptions behind the econometric model. Specifically, most of the distributions of the amount of nutrients available per 1,000 calories are strongly skewed. Using logarithm transformations helps these distributions resemble more of a normal distribution.

adult male equivalents (AMEs). While the associations between other measures of household composition, such as having multiple adult heads (relative to single adult heads) and having elderly members within the household, are positive, the negative association for number of AMEs is much larger, leading to an overall negative association between the availability of vitamin A and household size and composition.[30] This relationship is common in nearly all vitamin and mineral regressions presented in this chapter and is a result of dividing the amount of the nutrient by total calories when defining the dependent variable. That is, there is a strong positive association between the amount of vitamin A and the number of AMEs (see the NFSPS-based findings in Cohen et al. 1999), but the concentration of vitamin A per 1,000 calories of food used is lower in larger households because of the positive association between calories and household size.

Table IV.2 Multivariate Regression of Availability of Vitamin A per 1,000 Calories and Food Expenditures

Ln(total food expenditures)[a]	1.67	**
Ln(adult male equivalents)	-0.27	**
Ln(proportion of meals consumed away from home)	0.11	
Multiple adult heads of household (referent category is "single adult head of household")	0.18	**
One or more children in household (referent category is "no children in household")	0.12	
One or more elderly adult in household (referent category is "no elderly in household")	0.18	**
Race (referent category is "White, non-Hispanic")		
Black, non-Hispanic	-0.17	
Hispanic	-0.14	
Other	-0.07	
Geographic Residence (referent category is "Western")		
Northeast	-0.15	
Mid-Atlantic	-0.12	
Midwest	-0.14	
Southeast	-0.24	**
Southwest	-0.23	*
Mountain Plains	-0.19	
Household Location (referent category is "rural")		
Urban	-0.11	
Suburban	0.00	
Income to Poverty Ratio (referent category is "less than 1.0")		
1.0-1.3	0.08	
Above 1.3	0.12	
Constant	5.58	**
R-Square	0.09	

Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

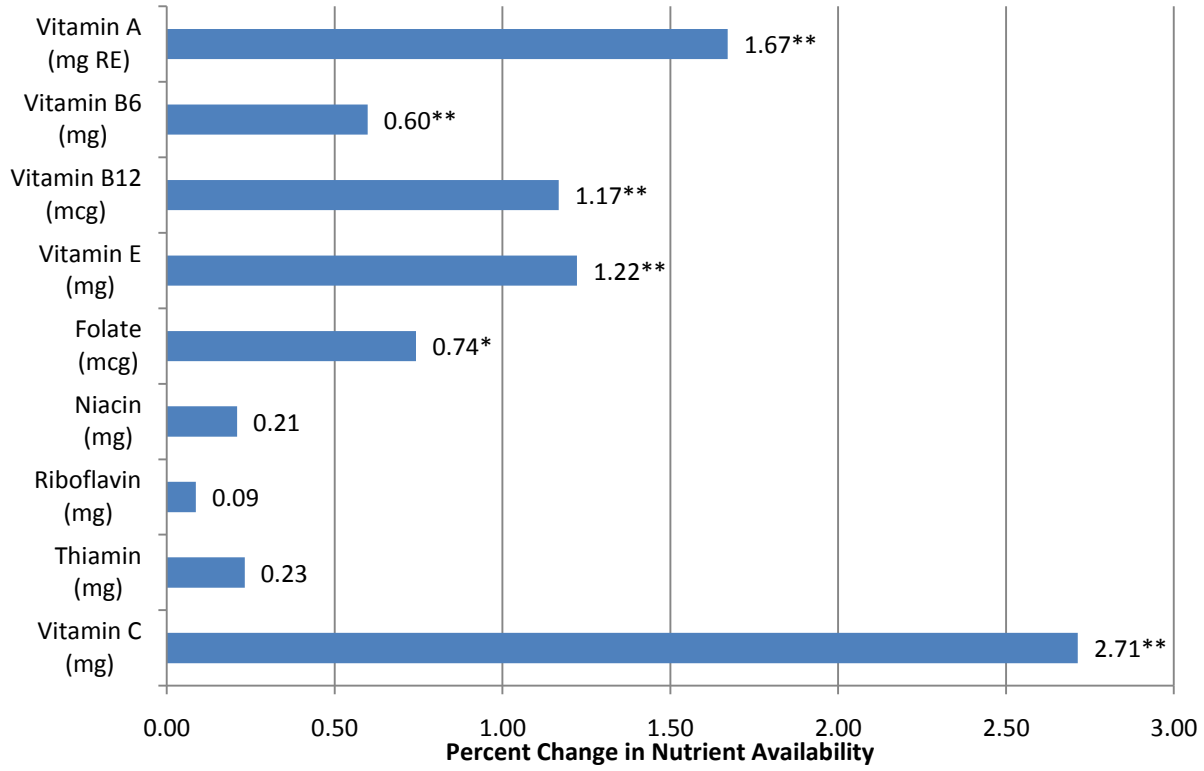
[a] The coefficient on ln(total food expenditures) has been multiplied by 10.

[30] For example, if an adult man joins a household previously headed by single adult woman, then the AME may increase by 225 percent (from say 0.8 to 1.8 assuming (1) that there are no children in the household and (2) that a woman has 80 percent of the energy requirements of a man). This will decrease the availability of vitamin A per 1,000 calories by 61 percent (equal to -0.17 times 225). In addition, the switch from a single adult household to a multiple adult household will only increase the availability of vitamin A by 18 percent. Thus, on net, there is a negative impact on the availability of vitamin A per 1,000 from an additional adult joining the household.

In addition, SNAP households living in the Southeast and Southwest consume foods with lower nutrient availability on average than households living in the Western Region. Income and race are not significantly associated with nutrient availability of vitamin A.

Figure IV.1 presents the associations between food expenditures and nutrient availability for the full set of vitamins. The association for the vitamin A row corresponds to the estimate in the first row of Table IV.2. SNAP participants that spend more on food use foods significantly greater in the availability of many vitamins, including vitamins A, B_6, B_{12}, C, E, and folate. The magnitudes of the associations (with a 10 percent increase in expenditures) range from 0.60 percent for vitamin B_6 to 2.71 percent for vitamin C. We do not have a strong basis for determining whether the magnitudes of these increases are small or large on a conceptual basis, though relative to the variation of the availability of vitamins in the sample, they appear to be small.[31] Of course, the size of each effect is intrinsically related to the increase in expenditures in that a larger increase in expenditures of 20 or 30 percent may result in a larger increase in nutrient availability, though the increase may not be proportional.

Figure IV.1 Percentage Change in Nutrient Availability (Vitamins) Associated with a 10 Percent Increase in Food Expenditures for SNAP Participants



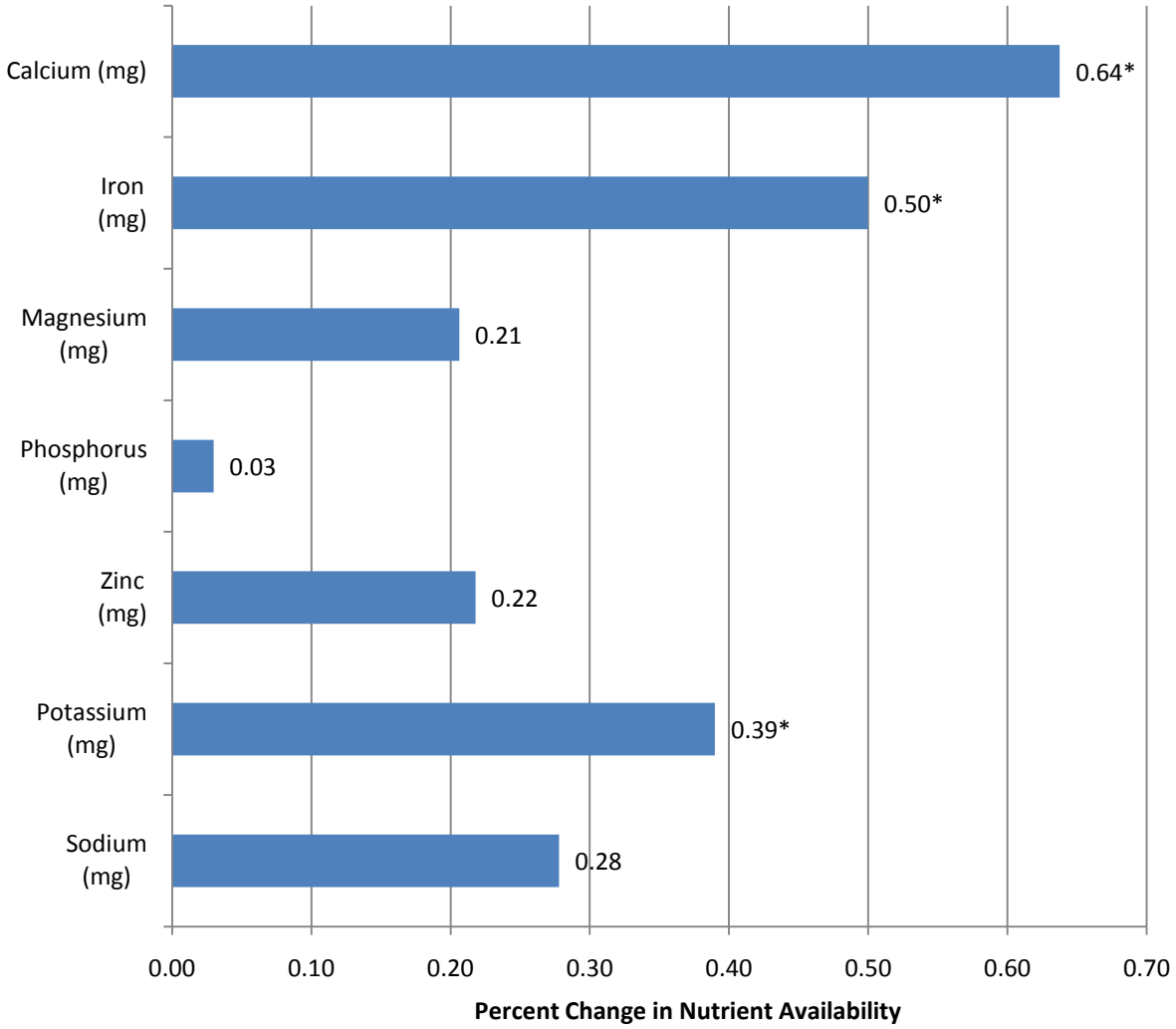
Source: 1996 NFSPS data

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

[31] This is based on the ratio of the increase in the mean availability of the vitamin in the sample to the standard deviation of the nutrient availability distribution.

Figure IV.2 presents the associations between food expenditures and nutrient availability for the full set of minerals. SNAP participants that spend more on food use foods significantly greater in the availability of several minerals, including calcium, iron, and potassium. The magnitudes of the associations (with a 10 percent increase in expenditures) range from 0.39 percent for potassium to 0.64 percent for calcium. As in the results for vitamins, the magnitudes of these associations are small relative to the variation of the distributions of nutrient availability in the sample.

Figure IV.2 Percentage Change in Nutrient Availability (Minerals) Associated with a 10 Percent Increase in Food Expenditures for SNAP Participants



Source: 1996 NFSPS data

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

We also examined the availability of fiber per 1,000 calories as well as the percentages of energy from macronutrients including protein, carbohydrates, saturated fat, and total fat. While the associations between expenditures and the availability of these nutrients were positive, they were not significant at the 0.05 level. In addition, using logistic regression analysis, we examined how household expenditures are related to the likelihood of a household meeting nutritional standards (for saturated fat and fiber) relative to not meeting standards or falling in a certain dietary range

recommended by U.S. Dietary Guidelines (for carbohydrates, protein, and total fat) relative to using these nutrients above or below the AMDR. (See Chapter II for a description of the methodology.) We found no significant associations at the 0.05 level between expenditures and the likelihood of meeting standards or falling with the AMDR range for these nutrients.

C. Diet Cost and Nutrient Availability Among Low-Income Individuals

The analysis in the previous section focused on the relationship between expenditures and nutrient availability for SNAP participants. Because of the small sample size in the NFSPS, we could not fully explore whether this relationship differed by household demographic and economic characteristics. In addition, because the sample consisted only of SNAP participants, we could not examine differences in the association by SNAP participation and eligibility status. In this section, we present results from a similar analysis using the NHANES to investigate whether there is a relationship between diet cost and nutrient availability and whether it differs for subgroups defined using demographic and economic characteristics, including SNAP participation and eligibility status. The NHANES data we used are limited to sample members with incomes below 300 percent of poverty. The data sets differ in the unit of observation (household in the NFSPS and individual in the NHANES) and the number of days of available food use or consumption data (food use over seven days in the NFSPS and food consumed over one day in the NHANES).

1. Nutrient Availability of Foods Consumed by Low-Income Individuals

Table IV.3 contains the mean values of nutrient availability for vitamins, minerals, and macronutrients consumed by low-income individuals in the NHANES.

2. Methodological Approach

The empirical framework is largely the same as in the NFSPS analysis. We estimate coefficients of regression models in which the natural logarithm of nutrient availability (amount of nutrient available per 1,000 calories) is the dependent variable and the natural logarithm of diet cost is the main independent variable.[32] We multiply the regression coefficient on diet cost by 10 so that it represents the change in nutrient availability associated with a 10 percent increase in diet cost. This is approximately $0.43 per day for the average individual in the NHANES sample (the mean diet cost is $4.28). For example, a coefficient of -0.50 indicates that a $0.43 increase in diet cost is associated with a 0.50 percent decrease (less than one percentage point) in the availability of a nutrient per 1,000 calories.

[32] For macronutrients, the dependent variable is the natural logarithm of the macronutrient's percentage of total energy.

Table IV.3 Mean Availability of Vitamins, Minerals, and Macronutrients for Low-Income Sample (Units per 1000 calories)

Vitamins	
Vitamin A	281 mcg RAE
Vitamin B_6	0.9 mg
Vitamin B_{12}	2.4 mcg
Vitamin E	3 mg
Folate	262 mcg
Niacin	10.6 mg
Riboflavin	1.0 mg
Thiamin	0.8 mg
Vitamin C	43 mg
Minerals	
Calcium	417 mg
Iron	7.3 mg
Magnesium	122 mg
Phosphorus	606 mg
Zinc	5.4 mg
Potassium	1,222 mg
Sodium	1,551 mg
Other Food Components	
Fiber	5.0 g
Cholesterol	126.5 g
Macronutrients[a]	
Protein	14.6 percent
Carbohydrate	52.3 percent
Total fat	32.8 percent
Saturated fat	11.0 percent
Monounsaturated fat	12.2 percent
Polyunsaturated fat	6.6 percent
Linoleic acid	5.8 percent
Linolenic acid	0.6 percent
Sample Size	10,998

Source: 2001–2004 NHANES data

[a] Expressed as percentage of total available calories

The set of explanatory variables in the regression model differ from those in the NFSPS analysis, in part because the unit of observation is the individual rather than the household. This set consists of SNAP participation and eligibility status, gender, age, race and ethnicity, education, marital status, and income.

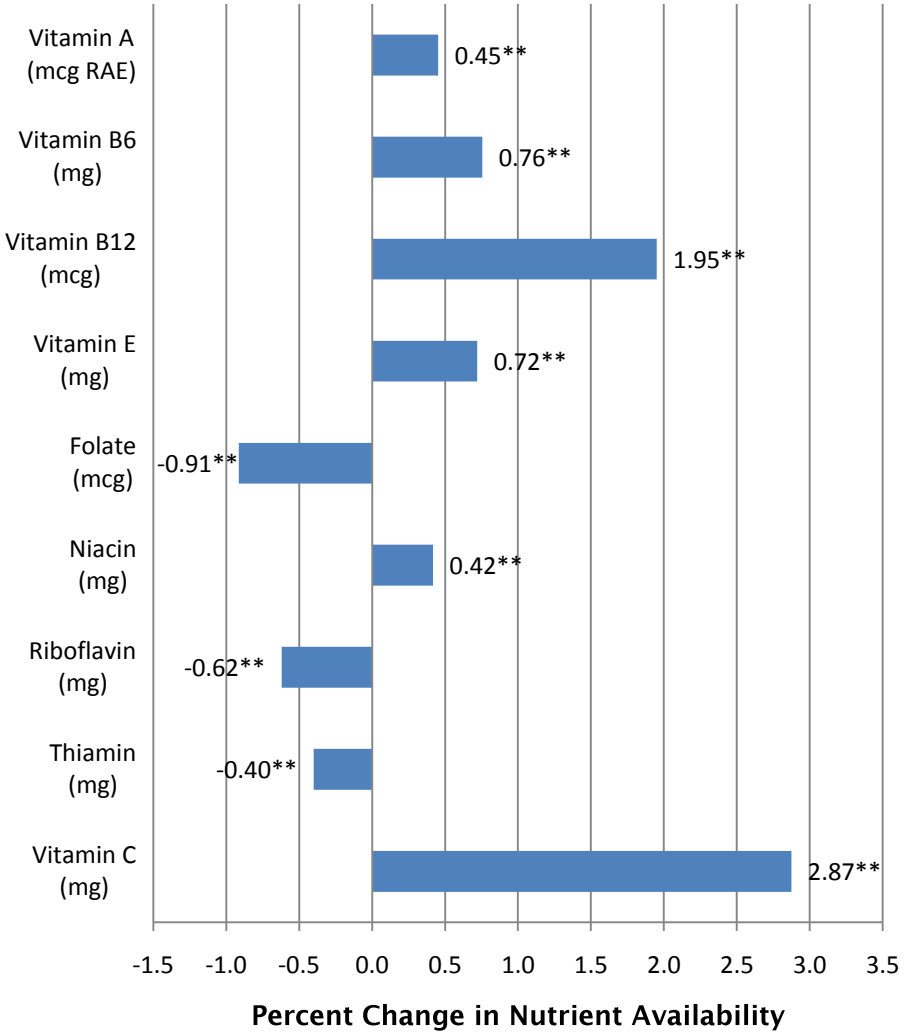
The regression using the full sample includes the full set of demographic and economic variables. We also estimate the coefficients of regression models using subsamples defined by each of these variables, such as male and female subgroups for gender. This enables us to determine whether the relationship between diet cost and nutrient availability exists for each subsample (for example, males) and if it differs across subsamples (for example, males versus females).

When presenting these results, we focus only on the associations between diet cost and nutrient availability and exclude the remaining regression coefficients from the tables and figures. These coefficients can be found in the tables in Appendix D.

3. Estimates of the Association Between Diet Cost and Nutrient Availability

Low-income individuals with greater diet cost consume foods with greater amounts of vitamins A, B_6, B_{12}, E, and C, and niacin and smaller amounts of folate, riboflavin, and thiamin per 1,000 calories (Figure IV.3). The magnitudes of the associations with a 10 percent increase in diet cost range from -0.91 percent for folate to 2.87 percent for vitamin C. Thus, on a per 1,000-calorie basis, individuals with greater diet cost consume a mix of foods that provide more of most vitamins nutrients than the foods consumed by individuals with lower diet cost. As in the NFSPS results, the magnitudes of these associations are small relative to the variation in the distributions of nutrient availability in the sample.

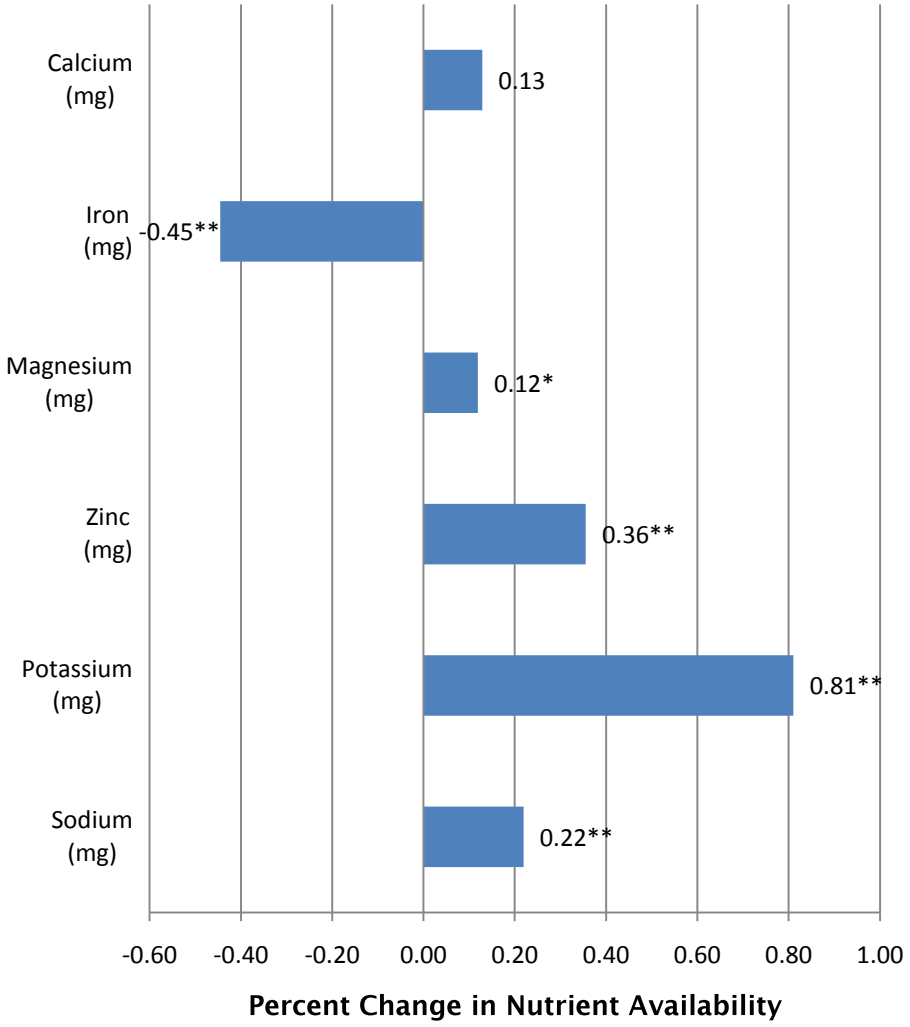
Figure IV.3 Percentage Change in Nutrient Availability (Vitamins) Associated with a 10 Percent Increase in Diet Cost for Low-Income Individuals



Source: 2001–2004 NHANES data with appended price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Turning to minerals, low-income individuals with greater diet cost consume foods with greater amounts of magnesium, zinc, potassium, and sodium and smaller amounts of iron per 1,000 calories (Figure IV.4). The magnitudes of the positive associations with a 10 percent increase in diet cost range from 0.12 percent for magnesium to 0.81 percent for potassium.

Figure IV.4 Percentage Change in Nutrient Availability (Minerals) Associated with a 10 Percent Increase in Diet Cost for Low-Income Individuals



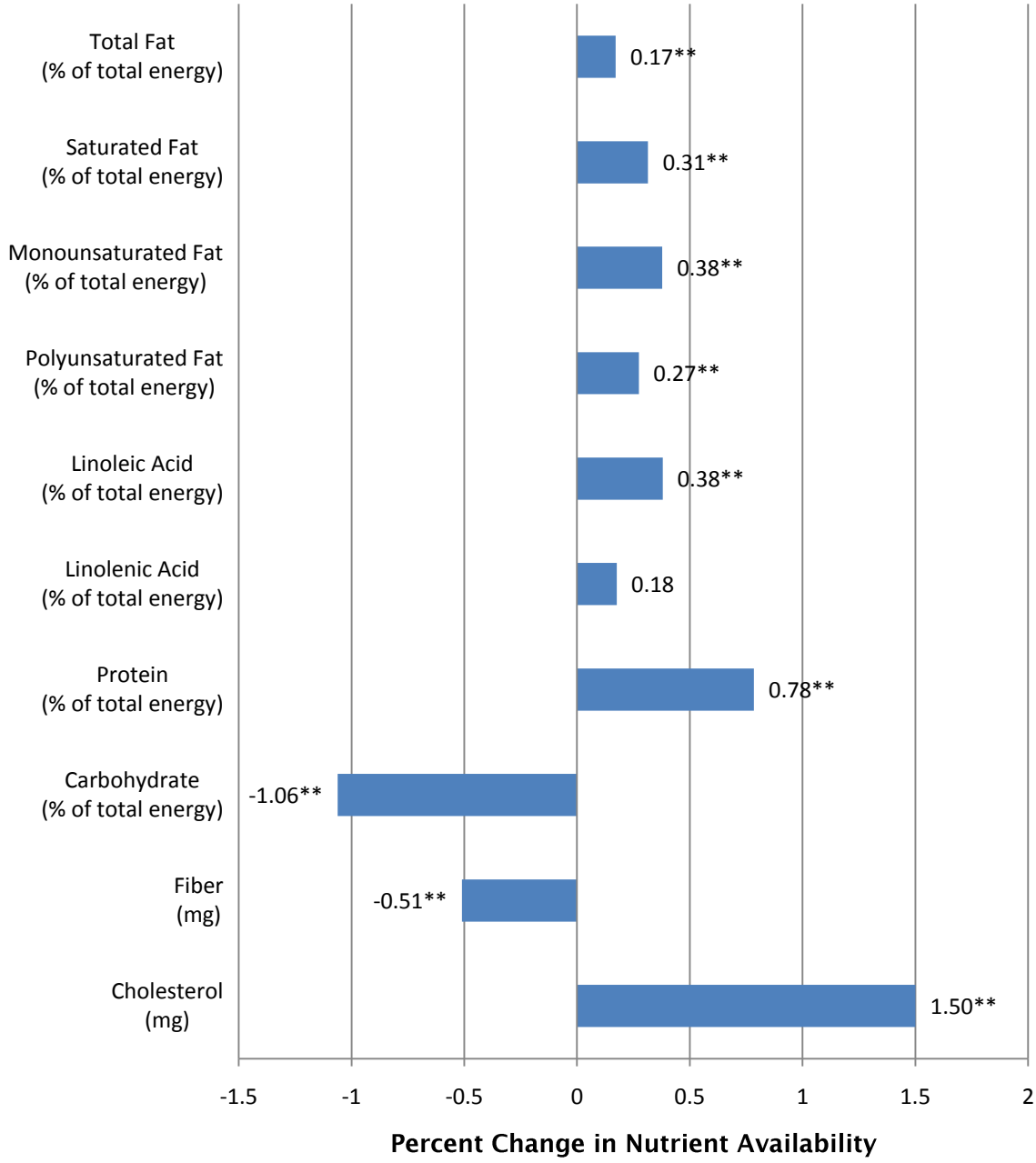
Source: 2001–2004 NHANES with appended price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

For macronutrients and other components, low-income individuals with greater diet cost consume foods with greater percentages of total energy from total fat; saturated, monounsaturated, and polyunsaturated fat; linoleic acid; protein; and cholesterol, and foods with smaller percentages of total energy from carbohydrates and fiber (Figure IV.5). The magnitudes of the positive associations with a 10 percent increase in food expenditures range from 0.17 percent for total fat to 1.50 percent for cholesterol.

Figure IV.5 Percentage Change in Nutrient Availability (Macronutrients and Other Components) Associated with a 10 Percent Increase in Diet Cost for Low-Income Individuals



Source: 2001–2004 NHANES with appended price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

4. Estimates of the Association Between Diet Cost and Nutrient Availability for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

In this section we present the NHANES results for the same regression model, but using subgroups defined by SNAP participation and eligibility group. Each figure shows whether the associations between diet cost and nutrient availability exist for each participation and eligibility group.

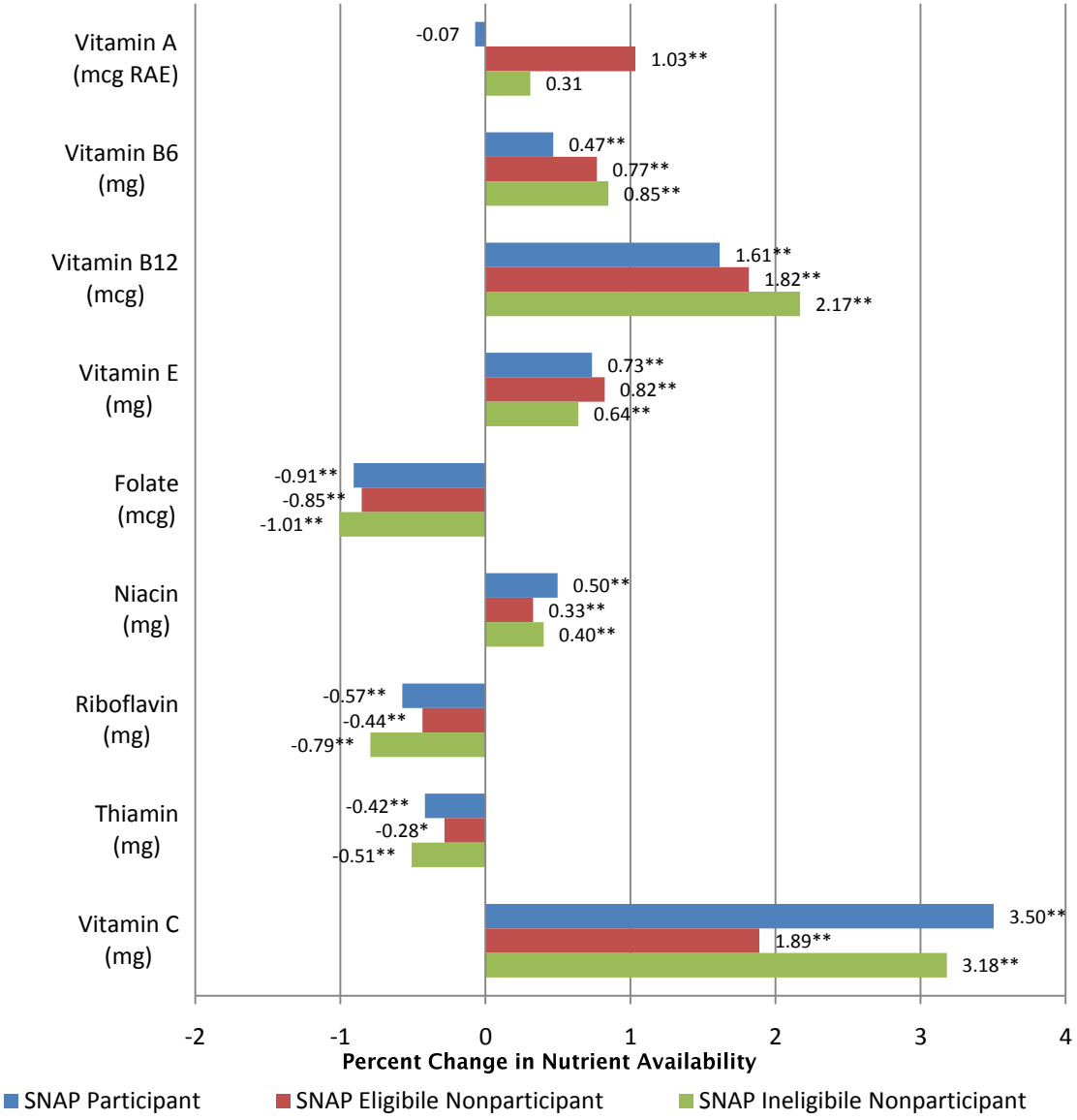
Overall, SNAP participants with greater diet cost consume foods with greater amounts of vitamins B_6, B_{12}, C, and E, and niacin per 1,000 calories (Figure IV.6). However, they consume foods with lower amounts of folate, riboflavin, and thiamin per 1,000 calories.

The relationships between diet cost and availability of vitamins is similar for SNAP eligible and ineligible nonparticipants compared to SNAP participants. The main difference is that only eligible nonparticipants with greater diet cost consume greater amounts of vitamin A; there is no such relationship for participants and ineligible nonparticipants.

Turning to minerals, SNAP participants with greater diet cost consume foods with greater amounts of zinc and potassium per 1,000 calories of food consumed (Figure IV.7). Unlike eligible and ineligible nonparticipants for whom there is no statistically significant relationship, SNAP participants also consume greater amounts of sodium per 1,000 calories. Finally, eligible and ineligible nonparticipants with greater diet cost consume smaller amounts of iron per 1,000 calories of food consumed, but there is no relationship for SNAP participants.

For macronutrients and other components, SNAP participants with greater diet cost consume foods with greater percentages of total energy from saturated, monounsaturated, and polyunsaturated fat; linolenic acid; and protein, and foods with smaller percentages of total energy from carbohydrates (Figure IV.8). The relationships are similar compared to eligible and ineligible nonparticipants. However, for eligible nonparticipants there are no relationships between diet cost and the availability of polyunsaturated fat and linolenic acid.

Figure IV.6 Percentage Change in Nutrient Availability (Vitamins) Associated with a 10 Percent Increase in Diet Cost for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

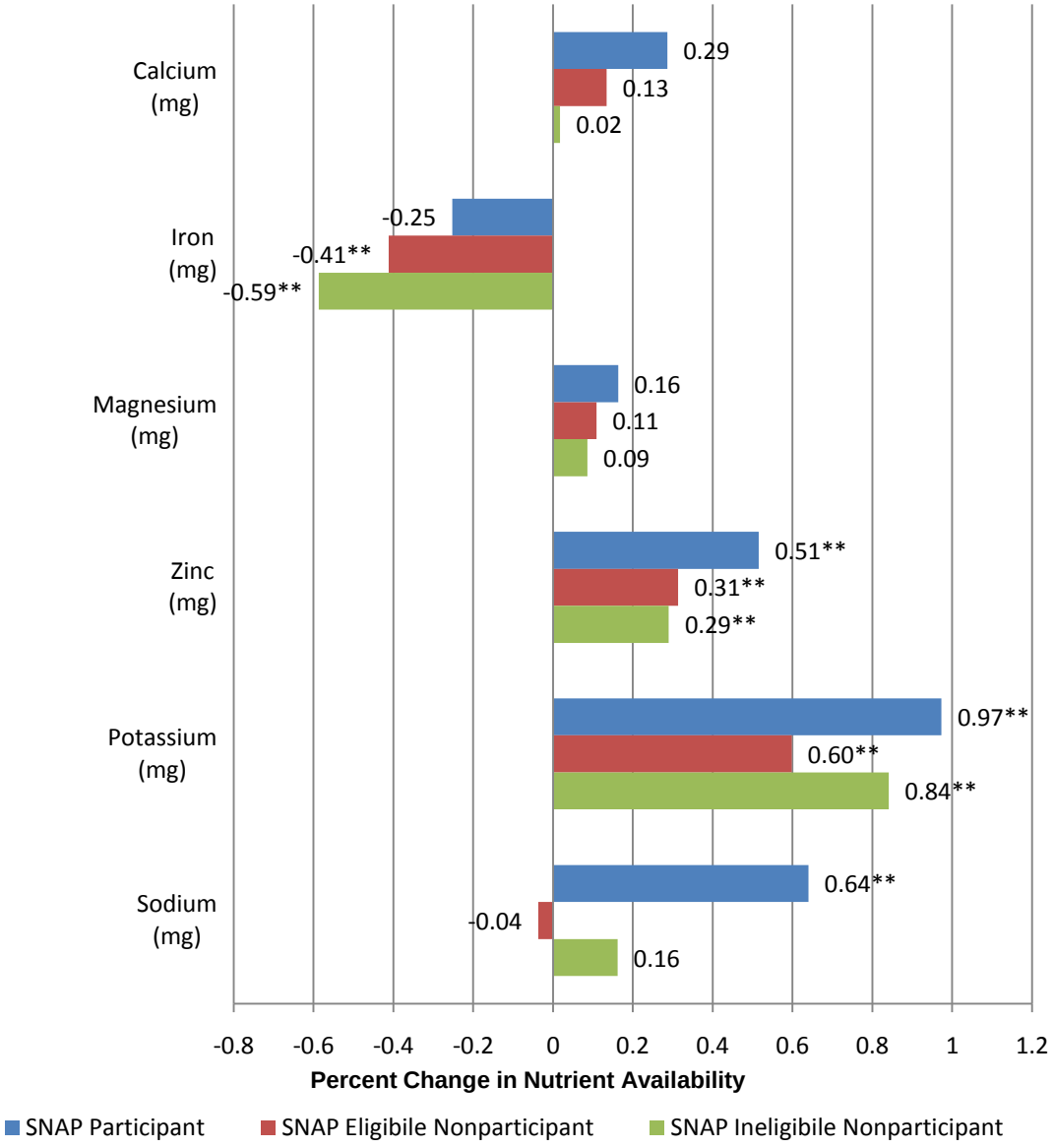


Source: 2001–2004 NHANES with appended price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure IV.7 Percentage Change in Nutrient Availability (Minerals) Associated with a 10 Percent Increase in Diet Cost for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

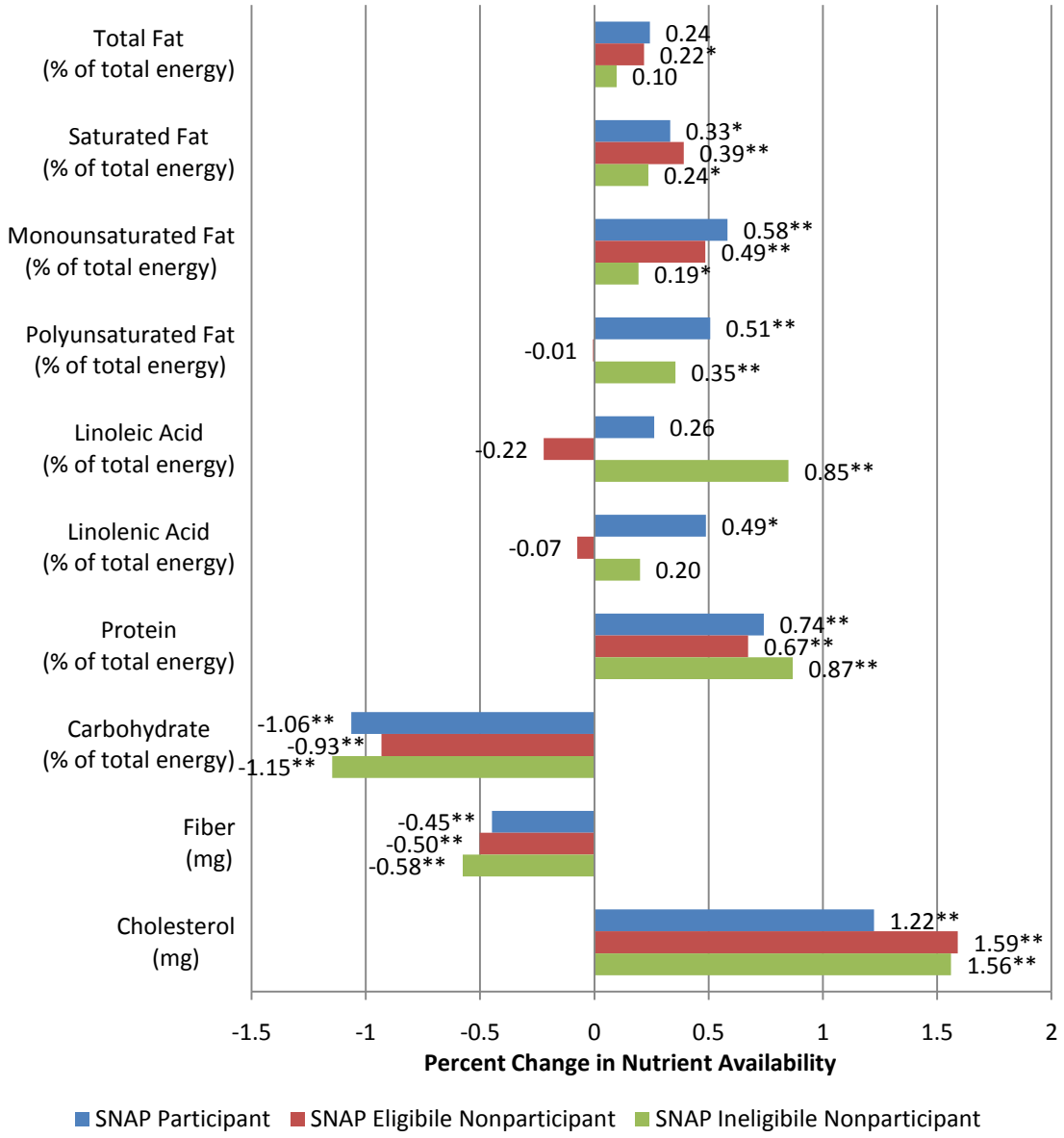


Source: 2001–2004 NHANES with appended price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure IV.8 Percentage Change in Nutrient Availability (Macronutrients and Other Components) Associated with a 10 Percent Increase in Diet Cost for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants



Source: 2001–2004 NHANES with appended price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

The analysis based on the NFSPS shows SNAP participant households that spend more on food use foods with greater amounts of the following nutrients: vitamins A, B6, B12, C, and E, folate, calcium, iron, and potassium per 1,000 calories. The NHANES results from the analysis of diet cost and nutrient availability for SNAP participants supported many of these findings. However, several differences across the sets of findings do exist. Whereas SNAP participant households in the NFSPS who spend more on food use greater amounts of vitamin A, calcium, and iron per 1,000 calories, there is no relationship between diet cost and the availability of these nutrients per 1,000 calories for SNAP participants in the NHANES. In addition, the association between diet cost and the concentration of folate is negative in the NHANES, but positive in the NFSPS.

While the analyses based on the NFSPS and NHANES are similar, several important differences between the two data sets warrant caution in comparing results. First, the unit of observation is the household in the NFSPS and the individual in the NHANES. Second, the recall period is seven days for food use in the NFSPS and one day for food consumption in the NHANES. Third, the NFSPS data were obtained in 1996, whereas the NHANES data are from 2001-2004.

It is difficult to identify how these differences might affect the results. For example, the household more closely resembles a SNAP unit, providing a more appropriate context with which to evaluate the expenditure/diet quality association among SNAP participants. However, having the household as the unit of analysis may also weaken the ability to obtain an estimate of this association that is not dependent on other factors such as household composition.[33] In addition, the complicated system relating household and individual consumption preferences, budget decisions, nutrition knowledge, food prices, and food purchase locations may have been altered by changing economic conditions, public policy, and cultural norms between the 1996 and 2001-2004 survey periods. These differences should be considered when synthesizing results from the two sets of analyses.

5. Estimates of the Association Between Diet Cost and Nutrient Availability for Other Demographic and Economic Subgroups

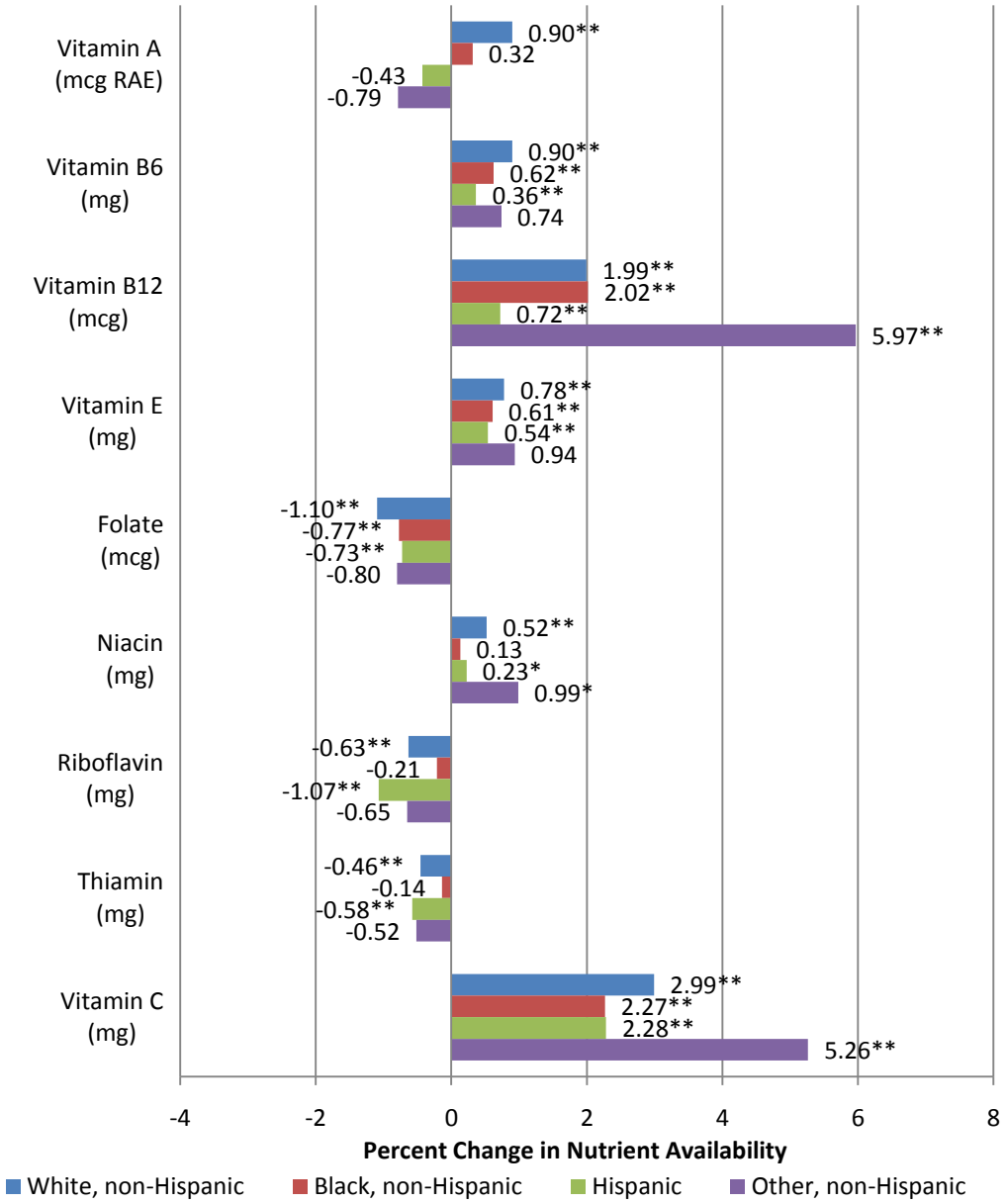
In this section we present the NHANES results for the same regression estimated using subgroups defined by demographic and economic characteristics (other than SNAP participation and eligibility). Each figure shows whether the associations between diet cost and nutrient availability exist for each subgroup. We present only a selected set of results such as the availability of vitamins by race and ethnicity and the availability of minerals by age. The full set of results is available in Appendix D. In general, when results for a specific vitamin, mineral, or macronutrient are significant for multiple categories within the subgroup, the association is in the same direction.

Figure IV.9 presents the associations between diet cost and the availability of several vitamins per 1,000 calories of food consumed by race and ethnicity. Unlike other individuals, white, non-Hispanic individuals with greater diet cost consume foods with greater amounts of vitamin A per

[33] To address possibility of an "omitted variables" problem related to household composition, we included several measures related to the presence of multiple adults, children, and elderly members of the household and also accounted for differences across households in the number of AMEs.

1,000 calories. All individuals with greater diet cost consume more vitamin B_6 and folate and less vitamin E per 1,000 calories, except non-white, non-black, non-Hispanic individuals.

Figure IV.9 Percentage Change in Nutrient Availability (Vitamins) Associated with a 10 Percent Increase in Diet Cost by Race and Ethnicity



Source: 2001–2004 NHANES with appended price data

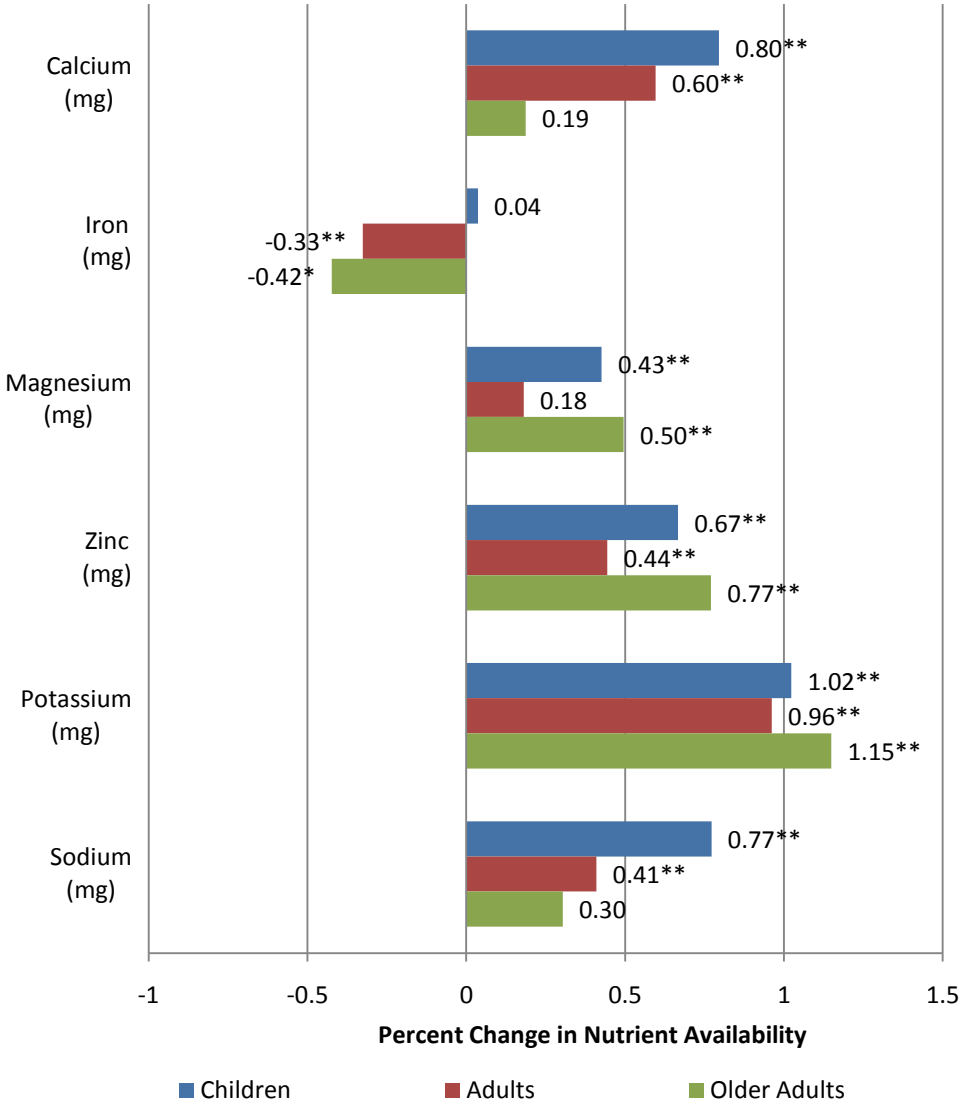
Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Note: Results for Minerals and Macronutrients for race and ethnicity categories are available in Appendix D.

Children with greater diet cost consume foods with greater amounts of calcium per 1,000 calories (Figure IV.10). This relationship also exists for adults, but not older adults. Children are also the only age group for which greater diet cost is not associated with lower amounts of iron per 1,000 calories of food consumed. Finally, children and adults with greater diet cost consume greater amounts of sodium per 1,000 calories.

Figure IV.10 Percentage Change in Nutrient Availability (Minerals) Associated with a 10 Percent Increase in Diet Cost for Children, Adults, and Older Adults



Source: 2001–2004 NHANES with appended price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Note: Results for Vitamins and Macronutrients for age categories are available in Appendix D.

V. ENERGY DENSITY

In this chapter, we examine whether spending more on food is associated with consuming foods of lower energy density. Using regression analysis, we estimate the association between total food expenditures and the energy density of foods used by a household in the NFSPS, and the association between diet cost (the value of food consumed) and the energy density of foods consumed by an individual in the NHANES. All analyses take into account differences in demographic and economic characteristics. We also determine whether these relationships differ across subgroups defined by these characteristics.

The *Dietary Guidelines* stresses the importance of consuming foods so that individuals stay within their energy needs. In developing the 2005 edition of the *Guidelines*, the Dietary Guidelines Advisory Committee concluded that, while the available scientific data were insufficient to determine the contribution of energy-dense foods to unhealthy weight gain and obesity, there was suggestive evidence that consuming energy-dense meals may contribute to excessive caloric intake and that, conversely, eating foods of low energy density may be a helpful strategy to reduce energy intake when trying to maintain or lose weight (USDHHS/USDA 2005).

The energy density of a food is defined as the available food energy per unit weight (e.g., calories per gram). Foods lower in energy density are those with a high water content, such as fruits, vegetables, and milk. Energy-dense foods tend to contain less water and more fat and sugar, for example, some fast foods, snacks, and desserts. Whole grains and cereal, which have low water content, are also energy dense (Drenowski 2005; Drenowski and Specter 2004).

We find the following relationships between food expenditures and the energy density of foods used in the NFSPS and between diet cost and the energy density of foods consumed in the NHANES. Many of these relationships differ by several demographic and economic characteristics, including SNAP participation and eligibility status, age, and education. Overall, the magnitudes of these relationships are relatively small when measured in units of the standard deviations of the energy density distributions.

- SNAP participant households that spend more on food use foods with lower energy density on average. Thus, on a per-gram basis, higher-expenditure households are using foods that provide a lower concentration of calories than the foods used by lower-expenditure households. However, when analyzing individual-level data for subgroups, only ineligible nonparticipants (with incomes between 130 and 300 percent of poverty) with greater diet cost consume foods with lower energy density overall; there is no significant association for SNAP participants and eligible nonparticipants at the individual level.
- Low-income individuals (incomes less than 300 percent of poverty) with greater diet cost consume foods of lower energy density overall. They also consume lower energy density vegetables and meat and beans.
- Children with greater diet cost (unlike adults and older adults) as well as individuals with less than a high school education (unlike those who have completed high school or college) with greater diet cost consume vegetables with lower energy density.

The chapter begins with a description of the energy density of foods used by SNAP participant households from their household food supply using the NFSPS. Next, we examine whether households that spend more on food use lower energy density foods. To obtain a more comprehensive picture of this relationship among low-income individuals, we then present results from a similar analysis of diet cost and the energy density of foods consumed using the NHANES. We also explore whether this relationship differs across subgroups defined by demographic and economic characteristics.

A. Energy Density of Foods Used by SNAP Participant Households

Energy density can be assessed using measures that include only foods or measures that also include beverages. Recent studies have concluded that unless drinking water is included among beverage intake (it is not included in the NFSPS or the NHANES prior to 2003-04), the energy density measure may be of limited usefulness because of variation in sources of beverages among individuals (Ledikwe et al. 2005). In addition, beverages tend to have a lower energy density and different effects on satiety than most foods (Drenowski and Spector 2004). As a result, our measure of energy density includes only foods—solid items and liquid/soft items that are typically consumed as foods, such as soups, ice cream, and infant formula.[34]

Table V.1 contains the mean energy densities for all foods and food subgroups used by SNAP participant households over a seven-day period as reported in the NFSPS. On average, the energy density of all foods used is 2.20 calories per gram. As one would expect, fruits and vegetables have the lowest energy density, followed by prepared foods, meats and beans, and grains and grain products. Energy density is highest for sweets, desserts, and salty snacks.

Table V.1 Mean Energy Density for SNAP Participants (Calories per Gram)

All Foods	**2.20**
Whole Fruit[a]	**0.64**
Vegetables	**0.53**
Grains and Grain Products	**3.28**
Breads and rolls	2.67
Ready-to-eat breakfast cereals	3.84
Milk Products (other than fluid milk)	**3.10**
Meat and Beans	**2.41**
Meat, poultry, and fish	2.48
Meat alternates[b]	2.13
Prepared Foods (Mixed Dishes)[c]	**2.08**
Sweets, Desserts, and Salty Snacks	**3.51**
Sample Size	957

Source: 1996 NFSPS data

[a]Excludes juice.

[b]Includes eggs, dry beans and peas, peanut butter, nuts, and seeds.

[c]Includes pizza, macaroni and cheese, Mexican-style entrees, sandwiches, chili, franks and beans, lasagna, spaghetti with meat sauce, and other meat and grain and/or vegetable mixtures.

[34] The results with infant formula included were nearly identical to the results without formula.

B. Food Expenditures and Energy Density Among SNAP Participant Households

1. Methodological Approach

To determine the association between food expenditures and the average energy density of the foods households use, we estimate regressions in which the natural logarithm of energy density is the dependent variable and the natural logarithm of total food expenditures is the main independent variable. By taking logarithmic transformations of both variables, we can use the regression coefficient on food expenditures to measure the percent change in energy density associated with a one percent increase in total food expenditures.[35] Because a one percent increase in expenditures is relatively small, when presenting figures or tables of the associations between expenditures and energy density, we multiply these coefficients by 10 so that they represent the change in energy density associated with a 10 percent increase in food expenditures. Given that the mean amount of food expenditures in the sample is equal to $59.13 (per week), a 10 percent increase is approximately equal to $5.91. Thus, a coefficient of -0.35 in a figure or table indicates that a $5.91 increase in food expenditures is associated with a 0.35 percent decrease (less than one percentage point) in the average energy density of the mix of foods used.

Table V.2 lists the independent variables included in each regression. We focus on the full set of regression coefficients only for the "all foods" analysis in order to show the set of variables that are included in the model. When presenting the food subgroup results, we focus only on the associations between food expenditures and energy density and exclude the remaining coefficients from the tables and figures. These coefficients can be found in the tables in Appendix E.

2. Estimates of the Association Between Food Expenditures and Energy Density

SNAP participants that spend more on food use foods with lower energy density. This is shown in Table V.2, which presents the regression results for all foods. Food expenditures are negatively associated with energy density, with a 10 percent increase in expenditures associated with a 0.569 percent decrease in the mean energy density of foods used. This suggests that the foods used by higher expenditure households provide a lower concentration of calories per gram than foods used by lower expenditure households. Because demographic and economic characteristics such as measures of household composition and income are included in the regression, the estimated association between expenditures and energy density is most likely not due to differences in these characteristics across households.

The coefficients for the demographic and economic characteristic variables in Table V.2 show how mean energy density levels differ across households. Energy density is higher for larger households (as measured by the natural logarithm of AMEs) and for households that eat a greater proportion of meals away from home. It is lower for households with multiple adult heads or those containing an elderly member, and for households with income greater than 130 percent of poverty. Race is not significantly associated with energy density.

[35] It also helps to reduce the risk of heteroscedasticity, adding greater validity to the assumptions behind the econometric model.

Table V.2 Multivariate Regression of Energy Density and Food Expenditures for All Foods

Ln(total food expenditures)[a]	-0.569	**
Ln(adult male equivalent)	0.118	**
Ln(proportion of meals consumed away from home)	0.063	*
Multiple adult heads of household (referent category is "single adult head of household")	-0.055	**
One or more children in household (referent category is "no children in household")	0.018	
One or more elderly adult in household (referent category is "no elderly in household")	-0.060	**
Race (referent category is "White, non-Hispanic")		
Black, non-Hispanic	0.018	
Hispanic	-0.020	
Other	-0.032	
Geographic Residence (referent category is "Western")		
Northeast	-0.011	
Mid-Atlantic	0.036	
Midwest	0.039	
Southeast	0.051	
Southwest	0.044	
Mountain Plains	0.008	
Household Location (referent category is "rural")		
Urban	-0.004	
Suburban	-0.017	
Income-to-Poverty Ratio (referent category is "less than 1.0")		
1.0-1.3	-0.038	
Above 1.3	-0.055	*
Constant	0.929	**
R-Square	0.120	

Source: 1996 NFSPS data

Note: * or ** denotes estimate is statistically significant at the 0.01 or 0.05 level.

[a]The coefficient on ln(total food expenditures) has been multiplied by 10.

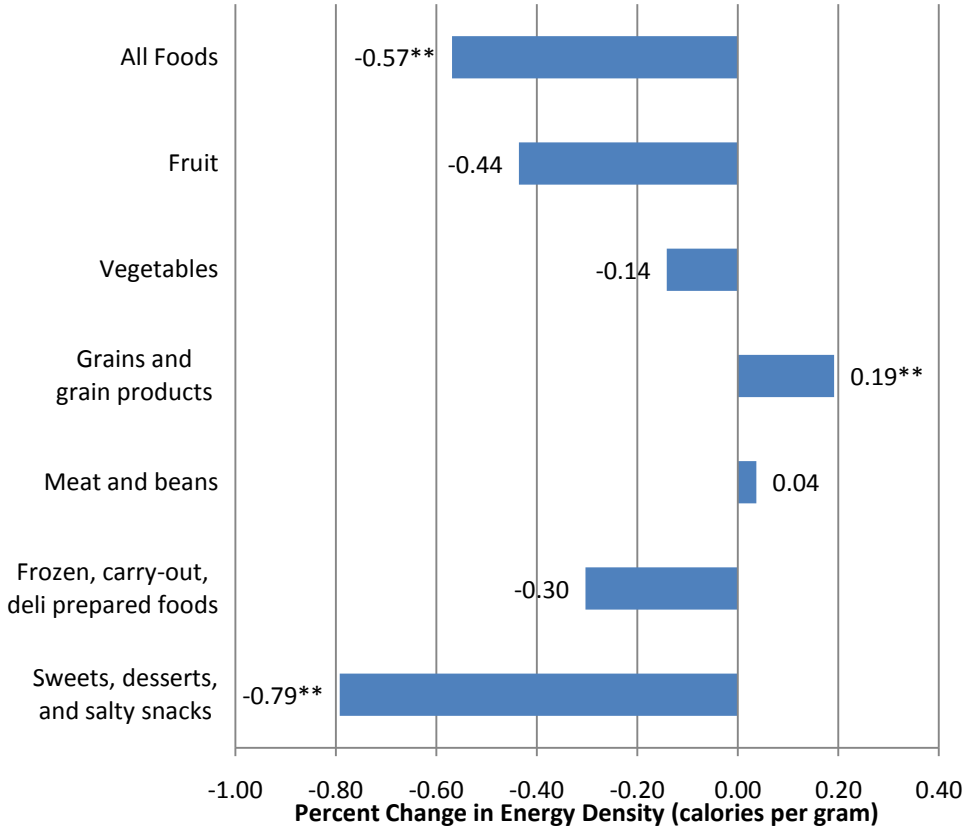
Figure V.1 presents the associations between food expenditures and energy density for all foods and for food subgroups. The association for the "All Foods" row corresponds to the estimate in the first row of Table V.2. SNAP participants that spend more on food use foods significantly lower in energy density overall. A 10 percent increase in expenditures is associated with a 0.57 percent decrease in the energy density of foods consumed. We do not have a strong basis for determining whether the magnitude of this decrease is small or large on a conceptual basis, though relative to the variation of energy density across households in the sample, it appears to be small.[36] Of course, the size of the effect is intrinsically related to the increase in expenditures in that a larger increase in expenditures of 20 or 30 percent may result in a larger decrease in energy density, though the decrease may not be proportional.[37]

[36] This is based on the ratio of the decrease in the mean value of energy density in the sample to the standard deviation of the energy density distribution.

[37] Sensitivity analyses examining differences in the association between expenditures and energy density by expenditure subgroup are presented in Appendix I. Though statistically insignificant at conventional levels, the magnitudes of the associations are found to be decreasing with expenditures.

SNAP participant households also use lower energy density sweets, desserts, and salty snacks and higher energy density grains and grain products. The magnitudes of the associations (with a 10 percent increase in expenditures) range from -0.79 percent for sweets, desserts, and salty snacks to 0.19 percent for grains and grain products. As in the "All Foods" result, the magnitudes of these associations are small relative to the variation in the energy density distribution in the sample.

Figure V.1 Percentage Change in Energy Density Associated with a 10 Percent Increase in Food Expenditures for SNAP Participant Households, by Major Food Category



Source: 1996 NFSPS data
Note: * or ** denotes estimate is statistically significant at the 0.05 or 0.01 level, respectively.
Note: Results for the subcategories listed in Table V.1 are available in Appendix E.

In addition to accounting for differences in demographic and economic characteristics across households when estimating the relationship between expenditures and energy density, we also investigated whether this relationship differs for subgroups defined by some of these characteristics. Specifically, we estimated three separate regressions corresponding to the three household composition indicator variables included in the main regression. Each regression used the full sample and included an interaction variable between the household composition indicator variable and the natural logarithm of total food expenditures. We found no significant differences in the association between food expenditures and energy density among households with and without multiple adult heads; among households with and without children; and among households with and without elderly members.

C. Diet Cost and Energy Density Among Low-Income Individuals

The analysis in the previous section focused on the relationship between expenditures and energy density for SNAP participants. Because of the small sample size in the NFSPS, we could not fully explore whether this relationship differed by household demographic and economic characteristics. In addition, because the sample consisted only of SNAP participants, we could not examine differences in the association by SNAP participation and eligibility status. In this section, we present results from a similar analysis using the NHANES to investigate whether there is a relationship between diet cost and energy density and whether it differs across subgroups defined using demographic and economic characteristics, including SNAP participation and eligibility status. The NHANES data are limited to sample members with incomes below 300 percent of poverty. The data sets differ in the unit of observation (household in the NFSPS and individual in the NHANES) and the number of days of available food use or consumption data (seven days in the NFSPS and one day in the NHANES).

1. Energy Density of Foods Consumed by Low-Income Individuals

The mean energy density of all foods consumed by low-income individuals in the NHANES is 2.08 calories per gram (Table V.3). Fruits and vegetables have the lowest energy density, followed by mixed dishes, meats and beans, grains and grain products, and milk products. Energy density is highest for sweets, desserts, and salty snacks.

Table V.3 Mean Energy Density for Full Low-Income Sample for All Foods and by Food Subgroup (Calorie per Gram)

All Foods	**2.08**
Whole Fruit [a]	**0.71**
Vegetables	**1.06**
Grains and Grain Products	**2.71**
Breads and Rolls	3.21
Ready-to-Eat Breakfast Cereals	3.75
Milk Products (other than fluid milk)[b]	**3.14**
Meat and Beans	**2.42**
Meat, Poultry, and Fish	2.39
Meat Alternates	2.84
Mixed Dishes[c]	**1.91**
Sweets, Desserts, and Salty Snacks	**3.73**
Sample Size	10,998

Source: 2001-2004 NHANES appended with price data

[a]Excludes juice.

[b]Includes cheese, yogurt, and infant formula.

[c]Includes pizza, macaroni and cheese, Mexican-style entrees, sandwiches, chili, franks and beans, lasagna, spaghetti with meat sauce, and other meat and grain and/or vegetable mixtures.

2. Methodological Approach

The empirical framework is largely the same as in the NFSPS analysis. We estimate regressions in which the natural logarithm of energy density is the dependent variable and the natural logarithm

of diet cost is the main independent variable. We multiply the regression coefficient on food expenditures by 10 so that it represents the change in energy density associated with a 10 percent increase in diet cost. This is approximately $0.43 per day for the average individual in the NHANES sample (the mean diet cost is $4.28). For example, a coefficient of -0.35 indicates that a $0.43 increase in diet cost is associated with a 0.35 percent decrease (less than one percentage point) in energy density.

The regression using the full sample includes the full set of demographic and economic variables. We also estimate the regressions using subsamples defined by each of these variables, such as male and female subgroups for gender. This enables us to determine whether the relationship between diet cost and energy density exists for each subsample (for example, males) and if it differs across subsamples (for example, males versus females).

When presenting these results, we focus only on the associations between diet cost and energy density and exclude the remaining regression coefficients from the tables and figures. These coefficients can be found in the tables in Appendix E.

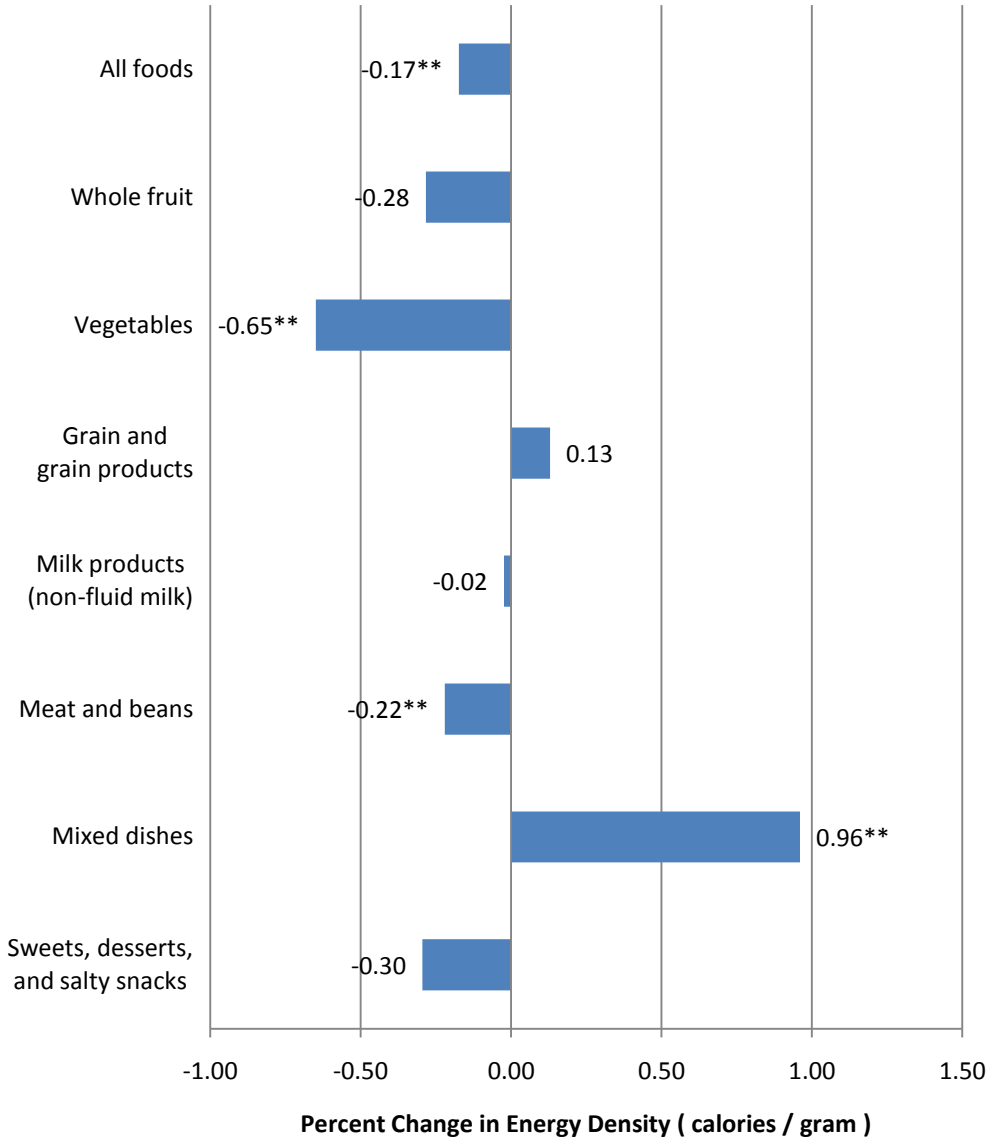
3. Estimates of the Association Between Diet Cost and Energy Density

Low-income individuals with greater diet cost consume foods with lower energy density overall (Figure V.2). Specifically, a 10 percent increase in diet cost is associated with a 0.17 percent decrease in the mean daily energy density for all foods consumed. Thus, on a per-gram basis, individuals with greater diet cost consume a mix of foods that provide less energy than the foods consumed by individuals with lower diet cost. [38]

Figure V.2 also presents the associations between diet cost and energy density for food subgroups. Low-income individuals with greater diet cost consume lower energy density vegetables and meat and beans. The magnitudes of the association (with a 10 percent increase in diet cost) are -0.22 percent for meat and beans to -0.65 for vegetables. Individuals with greater diet cost also consume higher energy density mixed dishes, with a 10 percent increase in diet cost associated with a 0.96 percent increase in the energy density of mixed dishes. As in the NFSPS results, the magnitudes of these associations are small relative to the variation in the energy density distribution in the sample.

[38] Sensitivity analyses examining differences in the association between diet cost and energy density by diet cost subgroup are presented in Appendix I. Though statistically insignificant at conventional levels, the associations are found generally to be positively related to diet cost.

Figure V.2 Percentage Change in Energy Density Associated with a 10 Percent Increase in Diet Cost for Low-Income Individuals, by Major Food Category



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

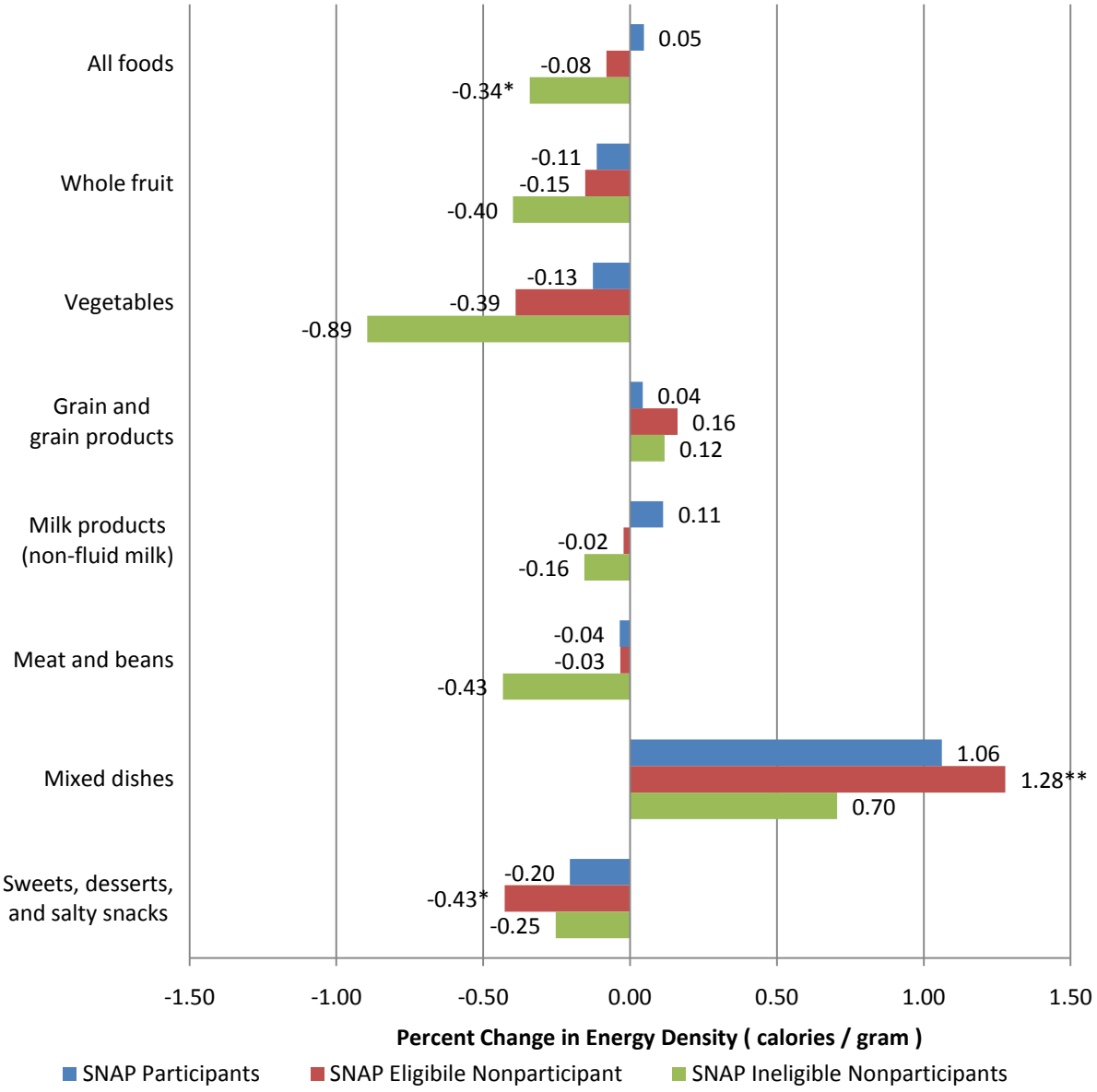
Note: Results for the subcategories listed in Table V.3 are available in Appendix E.

4. Estimates of the Association Between Diet Cost and Energy Density for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

In this section we present the NHANES results for the same regression estimated using subgroups defined by SNAP participation and eligibility group. Each figure shows whether the associations between diet cost and energy density for selected food subgroups exist for each subgroup.

Overall, only SNAP ineligible nonparticipants with greater diet cost consume foods of lower energy density (Figure V.3). There is no similar significant association for participants and eligible nonparticipants.

Figure V.3 Percentage Change in Energy Density Associated with a 10 Percent Increase in Diet Cost for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants, by Major Food Category



Source: 2001–2004 NHANES appended with price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.
Note: Results for the subcategories listed in Table V.3 are available in Appendix E.

Only SNAP eligible nonparticipants with greater diet cost consume higher energy density mixed dishes. These tend to contain higher fat meat and/or cheese, sauces, and spreads or are fried, whereas lower energy density mixed dishes are more likely to include poultry or fish, legumes or other meat substitutes, and vegetables.

The analysis based on the NFSPS shows SNAP participant households that spend more on food use less energy-dense foods. By contrast, when restricting the full low-income sample in the NHANES to SNAP participants, we find no significant association between greater diet cost and lower energy density overall (Figure V.3).

Several important differences between the two data sets warrant caution in comparing results. First, the unit of observation is the household in the NFSPS and the individual in the NHANES. Second, the recall period is seven days for food use in the NFSPS and one day for food consumption in the NHANES. Third, the NFSPS data were obtained in 1996, whereas the NHANES data are from 2001-2004.

It is difficult to identify how these differences might affect the results. For example, the household more closely resembles a SNAP unit, providing a more appropriate context with which to evaluate the expenditure/diet quality association among SNAP participants. However, having the household as the unit of analysis may also weaken the ability to obtain an estimate of this association that is not dependent on other factors such as household composition.[39] In addition, the complicated system relating household and individual consumption preferences, budget decisions, nutrition knowledge, food prices, and food purchase locations may have been altered by changing economic conditions, public policy, and cultural norms between the 1996 and 2001-2004 survey periods. These differences should be considered when synthesizing results from the two sets of analyses.

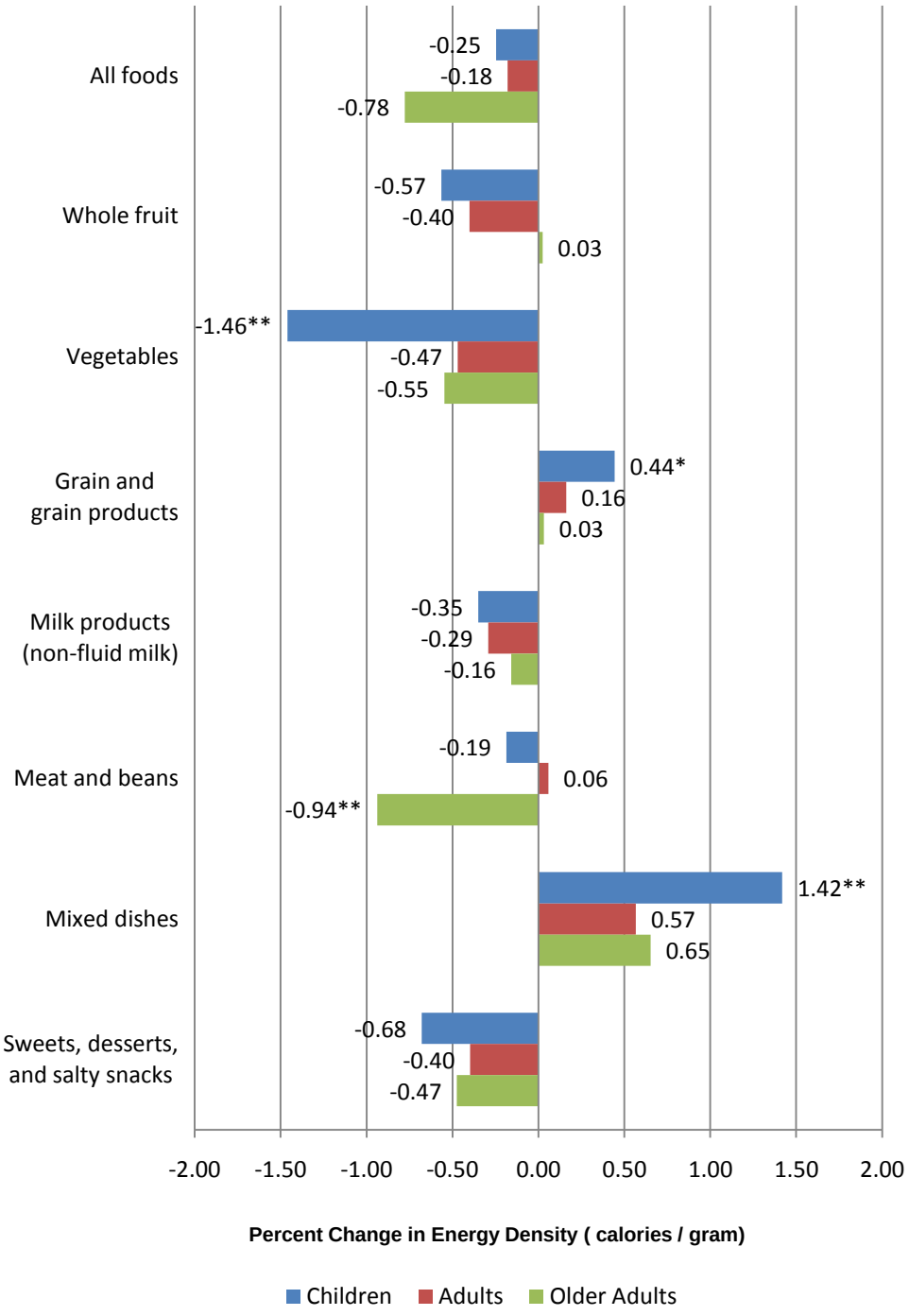
5. Estimates of the Association Between Diet Cost and Energy Density for Other Demographic and Economic Subgroups

In this section we present the NHANES results for the same regression estimated using subgroups defined by demographic and economic characteristics (other than SNAP participation and eligibility). Each figure shows whether the associations between diet cost and energy density exist for each subgroup.

Figure V.4 presents the associations between diet cost and energy density for foods consumed, by age. Children are the only age group, statistically speaking, to consume vegetables with lower energy density, the greater their diet cost. However, children with greater diet cost consume grain and grain products and mixed dishes with higher energy density. Older adults with greater diet cost consume meats and beans with lower energy density.

[39] To address possibility of an "omitted variables" problem related to household composition, we included several measures related to the presence of multiple adults, children, and elderly members of the household and also accounted for differences across households in the number of AMEs.

Figure V.4 Percentage Change in Energy Density Associated with a 10 Percent Increase in Diet Cost for Children, Adults, and Older Adults, by Major Food Category



Source: 2001–2004 NHANES appended with price data

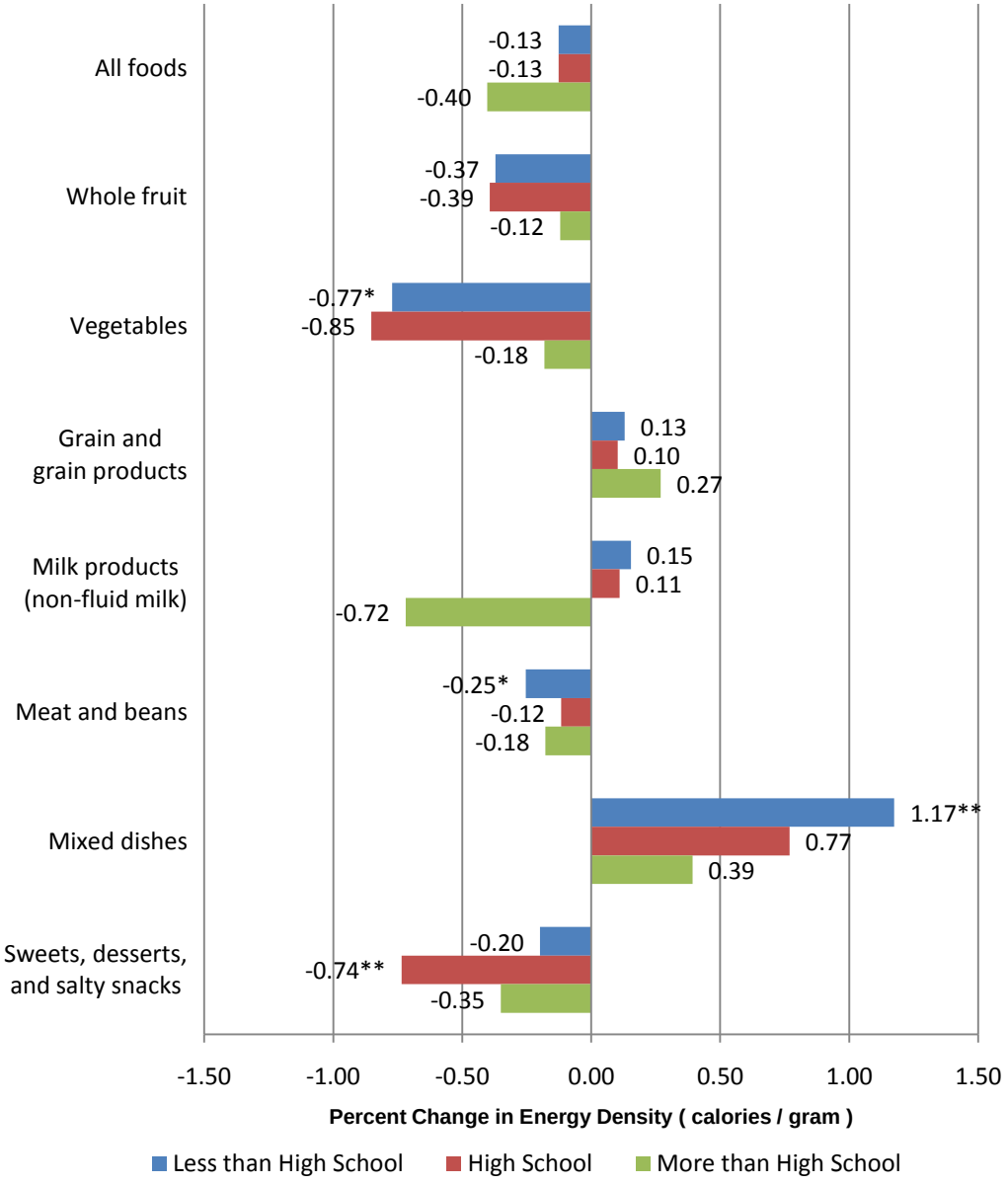
Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Note: Results for the subcategories listed in Table V.3 are available in Appendix E.

Individuals with less than a high school education with greater diet cost consume vegetables and meats and beans with lower energy density and mixed dishes with greater energy density (Figure V.5). These associations are not significant for individuals with more education.

Figure V.5 Percentage Change in Energy Density Associated with a 10 Percent Increase in Diet Cost for Individuals with Less than a High School Education, a High School Education, and More than a High School Education, by Major Food Category



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Note: Results for the subcategories listed in Table V.3 are available in Appendix E.

VI. NUTRIENT DENSITY

The *Dietary Guidelines for Americans* and MyPyramid recommendations emphasize the need for individuals to choose nutrient-dense foods to meet nutrient requirements without exceeding energy requirements. Nutrient-dense foods are defined as those that "provide substantial amounts of vitamins and minerals and relatively few calories." Selecting "low-fat forms of foods in each [food] group and forms free of added sugar" is recommended.[40] The *Dietary Guidelines* also provide examples of nutrient-dense foods—fruits and dark green and orange vegetables; fat-free and low-fat milk and milk products such as yogurt and cheese; lean meats, poultry, fish, and legumes; and regular and whole-grain products. In this chapter, we examine whether spending more on food is associated with consuming foods with greater nutrient density. The nutrient density of a food is expressed as a ratio that measures the food's nutrient contribution relative to its energy contribution. Using regression analysis, we estimate the association between total food expenditures and the nutrient density of foods used by a household in the NFSPS and the association between diet cost (the value of food consumed) and the nutrient density of foods consumed by an individual in the NHANES. All analyses take into account differences in demographic and economic characteristics. We also determine whether these relationships differ across subgroups defined by these characteristics.

We find the following relationships between food expenditures and the nutrient density of foods used in the NFSPS and between diet cost and the nutrient density of foods consumed in the NHANES. Many of these relationships differ by several demographic and economic characteristics including SNAP participation and eligibility status, age, and education. Overall, the magnitudes of these relationships are small relative to the variation in nutrient density across individuals and households in the samples.

- SNAP participant households who spend more on food use a more nutrient-dense mix of foods. Thus, on a calorie-per-calorie basis, higher-expenditure households are using foods that provide greater nutrients on average than the foods used by lower-expenditure households. This is also true for SNAP participants when analyzing individual-level data; however, the same does not hold true for eligible and ineligible nonparticipants.
- Low-income individuals (incomes less than 300 percent of poverty) with greater diet cost consume a mix of foods with higher nutrient density. They also consume more nutrient-dense fruits; vegetables; grains and grain products; meat and beans; and sweets, desserts, and salty snacks, and less nutrient-dense milk products.
- Unlike males, females with greater diet cost consume more nutrient-dense foods. This is also true for low-income individuals with income greater than 130 percent of poverty, but not individuals with income below this amount. Finally, children and adults (but not older adults) with greater diet cost consume more nutrient-dense fruits.

[40] It has been suggested that the *Dietary Guidelines* definition for nutrient-dense foods needs to be revisited. A practice paper of the American Dietetic Association on nutrient density (May 2007) provides a comprehensive description of the issues.

The chapter begins with a description of the nutrient density of foods used by SNAP participant households from their household food supply using the NFSPS. Next, we examine whether households that spend more on food use foods with greater nutrient density. To obtain a more comprehensive picture of this relationship among low-income individuals, we then present results from a similar analysis of diet cost and nutrient density using the NHANES. We also explore whether this relationship exists for subgroups defined by demographic and economic characteristics.

A. Nutrient Density of Foods Used by SNAP Participant Households

A critical issue in promoting nutritional awareness among food consumers and for researchers and policymakers is the development of a more precise definition and valid method to measure nutrient density. One approach, the Naturally Nutrient Rich score is a nutrients-to-calories ratio that considers nutrients commonly included in efforts to define healthy diets (Drewnowski, 2005). The Naturally Nutrient Rich score, as initially conceived, excludes fortified foods. For our analysis, we used a modified Naturally Nutrient Rich score—the Nutrient-Rich score—that is not limited to naturally occurring nutrients. We include fortified foods in the analysis because the nutrient database we used in analyzing the NFSPS data does not differentiate naturally occurring nutrients from those added during enrichment or fortification processes. In addition, fortified foods make important contributions to nutrient intakes (Subar et al. 1998a and 1998b).[41] The nutrient-rich scores presented in this report consider the nutrients shown in Table II.4.[42]

The nutrient-rich score for a food is constructed as the weighted average of the contributions of a selected set of its nutrients, with nutrient contributions measured as a percent of the recommended daily value (DV) contributed per 2,000 calories of the food (DVs are shown in Table II.4; derivation of the nutrient-rich score is described in Chapter II).

The nutrient-rich score provides a method of simultaneously assessing multiple key nutrients. Mean nutrient-rich scores must be interpreted with caution. The nutrient-rich score is not designed to assess nutrient adequacy. Higher nutrient-rich scores indicate a higher concentration of nutrients per calorie, but because the score is normalized to 2,000 calories, it does not provide an absolute measure of nutrient intake relative to DVs. Furthermore, nutrient-rich scores do not account negatively for excessive concentrations of food components such as saturated fat, cholesterol, sodium, and added sugars, which should be consumed in moderation. And finally, the score weights all nutrients equally without truncation. Thus, a person consuming 2,000 percent DV of one nutrient will have a higher nutrient-rich score from that single nutrient than a person consuming exactly 100 percent DV of all nutrients.

Table VI.1 contains the mean nutrient-rich scores for all foods and food subgroups used by SNAP participant households from their household food supply as reported in the NFSPS. The mean nutrient-rich score based on all foods used is 102. Among the food subgroups, vegetables

[41] See also The American Dietetic Association (2007).

[42] The nutrients are the same as those used by Drewnowski, with the following exceptions. Vitamin D was not included because it was not available in the NFSPS or NHANES data. Additional nutrients available in NHANES, such as the essential fatty acids linoleic acid and alpha-linolenic acid were not added in order to maintain comparability between the scores from each data set.

have the highest nutrient density, followed by milk products, total fruit, and grain and grain products. The mean nutrient-rich score is smallest for the sweets, desserts, and salty snacks.

Table VI.1 Mean Nutrient-Rich Scores for SNAP Participants

All Foods	**102**
Total Fruit	**135**
Whole fruit	124
100 percent juice	153
Vegetables	**251**
Grains and Grain Products	**126**
Breads and rolls	79
Ready-to-eat breakfast cereals	329
Milk and Milk Products	**141**
Fluid milk	162
Cheese and yogurt products	97
Meat and Beans	**115**
Meat, poultry, and fish	113
Meat alternates[a]	133
Prepared Foods (Mixed Dishes)[b]	**93**
Sweets, Desserts, and Salty Snacks	**44**
Sweets and desserts	29
Salty snacks	62
Beverages Other than Milk or 100 Percent Juice[c]	**99**
Sample Size	957

Source: 1996 NFSPS data

[a]Includes eggs, dry beans and peas, peanut butter, nuts, and seeds.

[b]Includes pizza, macaroni and cheese, Mexican-style entrees, sandwiches, chili, franks and beans, lasagna, spaghetti with meat sauce, and other meat and grain and/or vegetable mixtures.

[c]Includes coffee, tea, alcohol, fruit drinks, soda, and other sugar-sweetened drinks.

B. Food Expenditures and Nutrient Density Among SNAP Participant Households

1. Methodological Approach

To determine the association between food expenditures and the average nutrient density of the mix of foods households use, we estimate regressions in which the natural logarithm of the nutrient-rich score is the dependent variable and the natural logarithm of total food expenditures is the main independent variable. By taking logarithmic transformations of both variables, the regression coefficient on food expenditures measures the percent change in a household's nutrient-rich score associated with a one percent increase in total food expenditures.[43] Because a one percent increase in expenditures is relatively small, when presenting figures or tables of the associations between

[43] It also helps to reduce the risk of heteroscedasticity, adding greater validity to the assumptions behind the econometric model.

expenditures and nutrient density, we multiply these coefficients by 10 so that they reflect the change in nutrient density associated with a 10 percent increase in food expenditures. Given that the mean amount of food expenditures in the sample is equal to $59.13, a 10 percent increase is approximately equal to $5.91. Thus, a coefficient of 0.50 in a figure or table indicates that a $5.91 increase in food expenditures is associated with a 0.50 percent increase (less than one percentage point) in the household's nutrient-rich score for the mix of foods used.

Table VI.2 lists the independent variables included in each regression. We present the full set of regression coefficients only for the "all foods" analysis in order to show the reader what variables are included in the model. When presenting the food subgroup results, we focus only on the associations between food expenditures and nutrient-rich scores and exclude the remaining coefficients from the tables and figures. These coefficients can be found in the tables in Appendix F.

2. Estimates of the Association Between Food Expenditures and Nutrient Density

SNAP participants that spend more on food use foods with higher nutrient density. This is shown in Table VI.2, which presents the regression results for all foods. Food expenditures are positively associated with nutrient density, with a 10 percent increase in expenditures associated with a 0.458 percent increase in the mean nutrient-rich score of foods used. This suggests that the foods used by higher expenditure households provide a higher concentration of nutrients per calorie than foods used by lower expenditure households. Because demographic and economic characteristics, such as measures of household composition and income, are included in the regression, the estimated association between expenditures and nutrient-rich scores is not explained by differences in these characteristics across households.

The coefficients for the demographic and economic characteristic variables in Table VI.2 show how mean nutrient-rich scores differ across households. Larger households (as measured by the logarithm of the number of adult male equivalents (AMEs) consume foods with lower nutrient density (Table VI.2). This negative association is much larger than the positive associations between other measures of household composition, such as having multiple adult heads (relative to single adult heads) and having elderly members within the household, leading to an overall negative association between nutrient density and household size and composition.[44] In addition, SNAP households living in the Southeast and Southwest consume foods with lower nutrient density on average than households living the West. Income and race are not significantly associated with nutrient density.

[44] For example, if an adult man joins a household previously headed by single adult woman, then the AME may increase by 225 percent (from say 0.8 to 1.8 assuming (1) that there are no children in the household and (2) that a woman has 80 percent of the energy requirements of a man). This will decrease the nutrient-rich score by 26.3 percent (equal to -0.117 times 225). In addition, the switch from a single adult household to a multiple adult household will only increase the nutrient-rich score by 7.3 percent. Thus, on net, there is a negative impact on the nutrient-rich score from an additional male adult joining the household.

Table VI.2 Multivariate Regression of Nutrient-Rich Score and Food Expenditures for All Foods

Ln(total food expenditures)[a]	0.458	**
Ln(adult male equivalents)	-0.117	**
Ln(proportion of meals consumed away from home)	-0.049	
Multiple adult heads of household (referent category is "single adult head of household")	0.073	**
One or more children in household (referent category is "no children in household")	0.024	
One or more elderly adult in household (referent category is "no elderly in household")	0.059	**
Race (referent category is "White, non-Hispanic")		
Black, non-Hispanic	-0.029	
Hispanic	0.003	
Other	-0.024	
Geographic Residence (referent category is "Western")		
Northeast	-0.018	
Mid-Atlantic	0.004	
Midwest	-0.022	
Southeast	-0.071	*
Southwest	-0.076	*
Mountain Plains	-0.016	
Household Location (referent category is "rural")		
Urban	0.011	
Suburban	0.017	
Income to Poverty Ratio (referent category is "less than 1.0")		
1.0-1.3	0.020	
Above 1.3	0.023	
Constant	4.449	**
R-Square	0.072	

Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

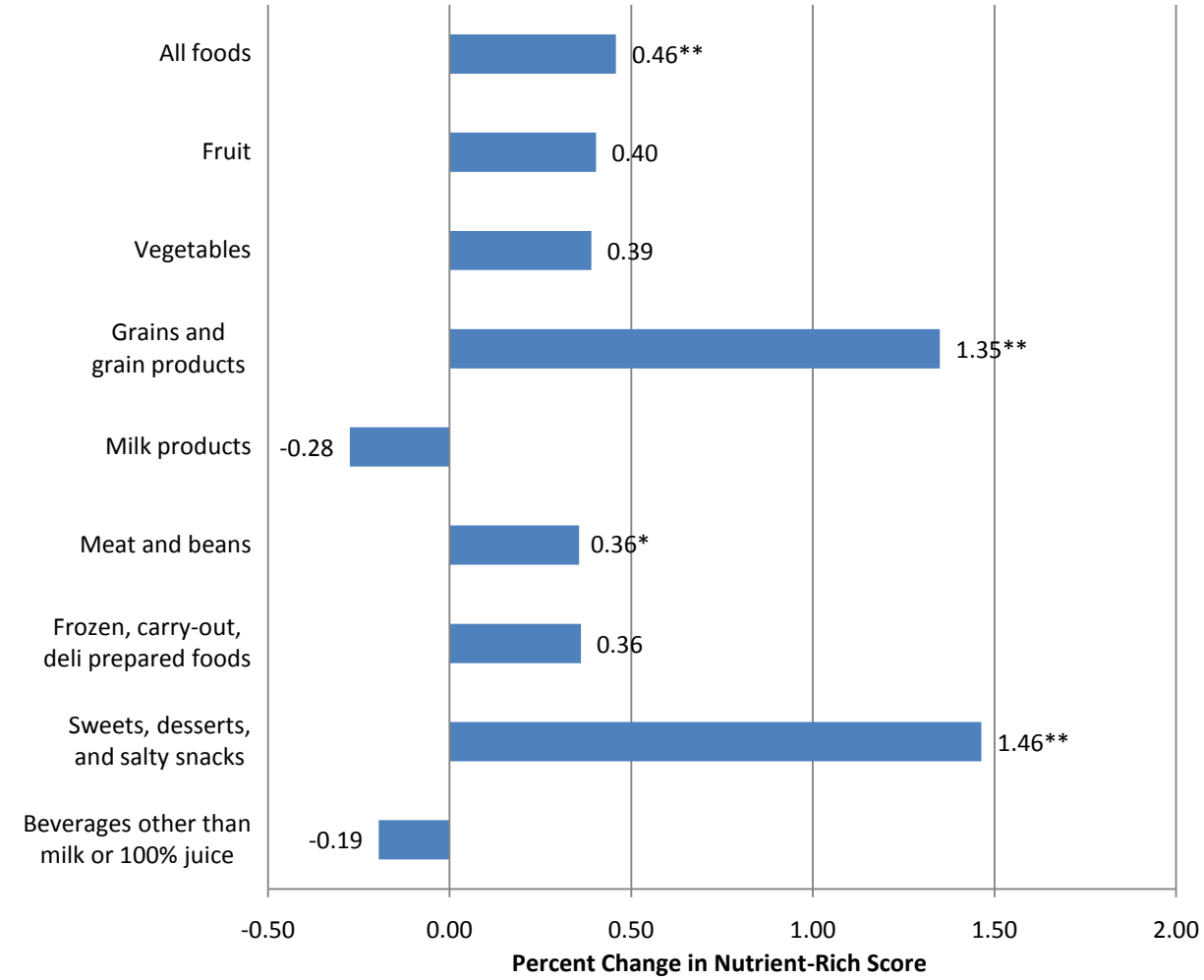
[a] The coefficient on ln(total food expenditures) has been multiplied by 10.

Figure VI.1 presents the associations between food expenditures and nutrient-rich scores for all foods and food subgroups. The association for the all-foods row corresponds to the estimate in the first row of Table VI.2. While SNAP participant households that spend more on food use a more nutrient-dense mix of foods overall, they also use grains and grain products; meat and beans; and sweets, desserts, and salty snacks with higher nutrient density. The magnitudes of the associations (with a 10 percent increase in expenditures) range from 0.36 percent for meat and beans to 1.46 percent for sweets, desserts, and salty snacks. We do not have a strong basis for determining whether the magnitudes of these increases are small or large on a conceptual basis, though relative to the variation of nutrient-rich scores across households in the sample, it appears to be small.[45] Of course, the size of the effect is intrinsically related to the increase in expenditures in that a larger increase in expenditures of 20 or 30 percent may result in a larger increase in nutrient density, though the increase may not be proportional.[46]

[45] This is based on the ratio of the increase in the mean nutrient-rich score in the sample to the standard deviation of the nutrient-rich score distribution.

[46] Sensitivity analyses examining differences in the association between expenditures and nutrient-rich scores by expenditure subgroup are presented in Appendix I. The associations are found to be inversely related to expenditures,

Figure VI.1 Percentage Change in Nutrient-Rich Score Associated with a 10 Percent Increase in Food Expenditures for SNAP Participants, by Major Food Category



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

In addition to accounting for differences in demographic and economic characteristics across households when estimating the relationship between expenditures and a SNAP participant household's nutrient-rich score, we also investigated whether this relationship differs for subgroups defined by household composition. We estimated three separate regressions corresponding to the three household composition indicator variables included in the main regression. Each regression included an interaction variable between the household composition indicator variable and the natural logarithm of total food expenditures. While households without an elderly member have lower mean nutrient-rich scores than households with an elderly member (100 versus 107), only households without an elderly member who spend more on food use a more nutrient-dense mix of

(continued)

with a positive association found among the lower expenditure subgroup and a negative association found among the higher expenditure subgroup.

foods from their household food supply; there is no significant association for households with an elderly member.

C. Diet Cost and Nutrient Density Among Low-Income Individuals

The analysis in the previous section focused on the relationship between expenditures and nutrient density for SNAP participant households. Because of the small sample size in the NFSPS, we could not fully explore whether this relationship differed by household demographic and economic characteristics. In addition, because the sample consisted only of SNAP participants, we could not examine differences in the association by SNAP participation and eligibility status. In this section, we present results from a similar analysis using the NHANES to investigate whether there is a relationship between diet cost and nutrient density and whether it differs for subgroups defined using demographic and economic characteristics, including SNAP participation and eligibility status. The NHANES data that we used are limited to sample members with incomes below 300 percent of poverty. The data sets also differ in the unit of observation (household in the NFSPS and individual in the NHANES) and the number of days of available food use or consumption data (seven days in the NFSPS and one day in the NHANES).

1. Nutrient Density of Foods Consumed by Low-Income Individuals

The mean nutrient-rich score for low-income individuals for all foods as reported in the NHANES is 105 (Table VI.3). Individuals' nutrient-rich scores were the highest for ready-to-eat breakfast cereals (408), which are often fortified with vitamins and minerals. Not surprisingly, sweets, desserts, and salty snacks consumed by low-income individuals had the lowest nutrient-rich score (mean of 45).

Table VI.3 Mean Nutrient-Rich Scores for Full Low-Income Sample for All Foods and By Food Subgroup Reported in the NHANES

All Foods	**105**
Total Fruit	**139**
Whole fruit	123
100 percent juice	165
Vegetables	**203**
Grains and Grain Products	**154**
Breads and rolls	77
Ready-to-eat breakfast cereals	408
Milk and Milk Products	**154**
Fluid milk	183
Cheese and yogurt	108
Meat and Beans	**130**
Meat, poultry, and fish	134
Meat alternates	120
Mixed Dishes[a]	**112**
Sweets, Desserts, and Salty Snacks	**45**
Sweets and desserts	39
Salty snacks	61
Sample Size	10,998

Source: 2001-2004 NHANES data
[a]Includes pizza, macaroni and cheese, Mexican-style entrees, sandwiches, chili, franks and beans, lasagna, spaghetti with meat sauce, and other meat and grain and/or vegetable mixtures.

2. Methodological Approach

The empirical framework is largely the same as in the NFSPS analysis. We estimate regressions in which the natural logarithm of an individual's nutrient-rich score is the dependent variable and the natural logarithm of diet cost is the main independent variable. We multiply the regression coefficient on diet cost by 10 so that it represents the change in nutrient-rich score associated with a 10 percent increase in diet cost. This is approximately $0.43 per day for the average individual in the NHANES sample (the mean diet cost is $4.28). For example, a coefficient of -0.35 indicates that a $0.43 increase in diet cost is associated with a 0.35 percent decrease (less than one percentage point) in an individual's nutrient-rich score.

The set of explanatory variables in the regression model differ from those in the NFSPS analysis, in part because the unit of observation is the individual rather than the household. This set consists of SNAP participation and eligibility status, gender, age, race and ethnicity, education, marital status, and income.

The regression using the full sample includes the full set of demographic and economic variables. We also estimate the regressions using subsamples defined by each of these variables, such as male and female subgroups for gender. This enables us to determine whether the relationship between diet cost and nutrient density exists for each subsample (for example, males) and if it differs across subsamples (for example, males versus females).

When presenting these results, we focus only on the associations between diet cost and nutrient-rich scores and exclude the remaining regression coefficients from the tables and figures. These coefficients can be found in the tables in Appendix F.

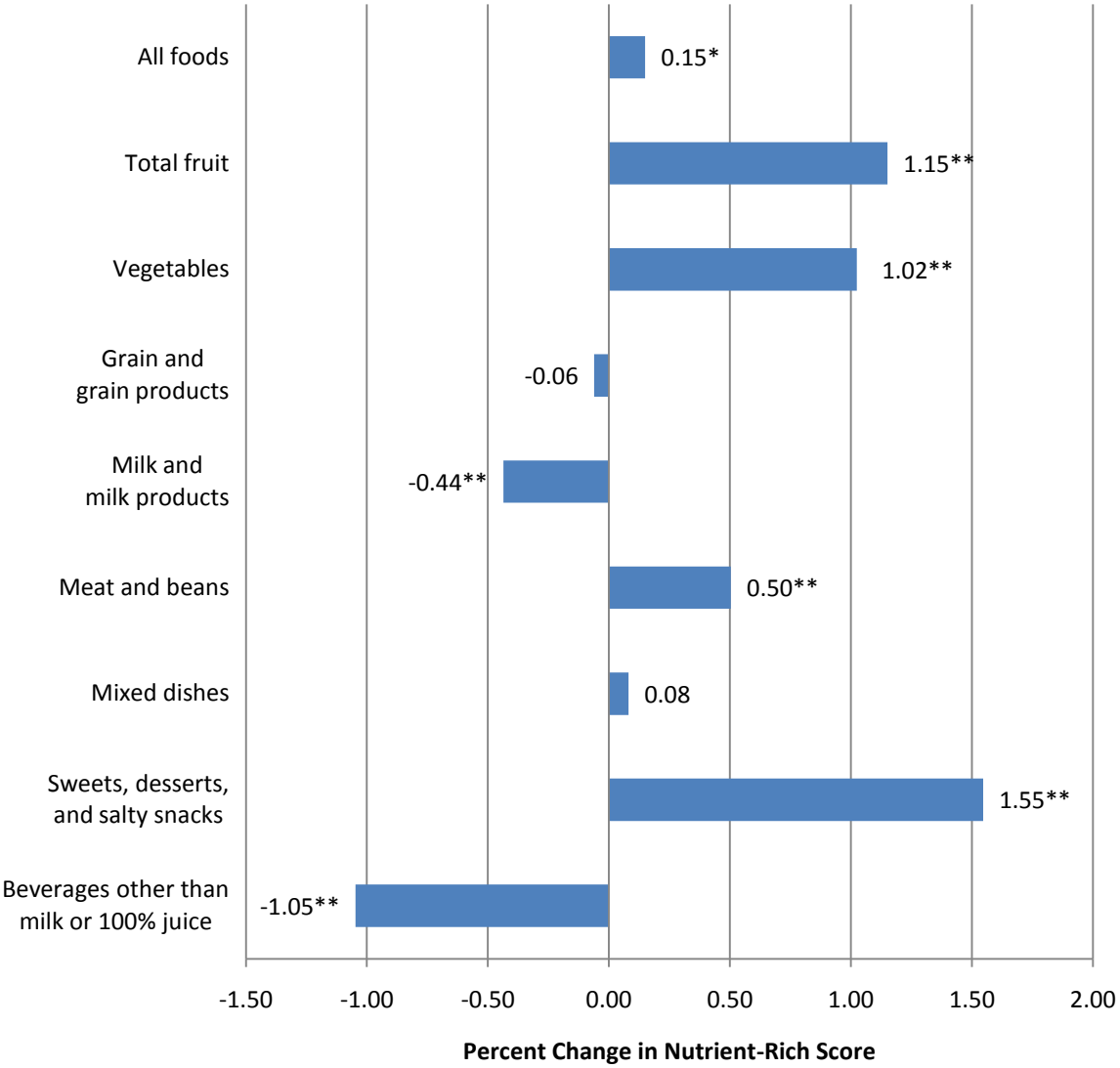
3. Estimates of the Association Between Diet Cost and Nutrient Density

Low-income individuals with greater diet cost consume foods with higher nutrient density (Figure VI.2). Specifically, a 10 percent increase in diet cost is associated with a 0.15 percent increase in the mean nutrient-rich score for all foods consumed. Thus, on a calorie-per-calorie basis, individuals with greater diet cost consume a mix of foods that provides greater nutrients than the foods consumed by individuals with lower diet cost. [47]

Figure VI.2 also presents the associations between diet cost and nutrient-rich scores for food subgroups. Low-income individuals with greater diet cost consume more nutrient-dense fruits; vegetables; meat and beans; and sweets, desserts, and salty snacks, and consume less nutrient-dense milk and milk products. The magnitudes of the positive associations (with a 10 percent increase in diet cost) range from 0.50 percent for meat and beans to 1.55 percent for sweets, desserts, and salty snacks. As in the NFSPS results, the magnitudes of these associations are small relative to the variation in nutrient-rich scores in the sample.

[47] Sensitivity analyses examining differences in the association between diet cost and nutrient-rich scores by diet cost subgroup are presented in Appendix I. The associations are found to be inversely related to diet cost, with the largest positive association found among the lowest diet cost subgroup and the largest negative association found among the highest diet cost subgroup.

Figure VI.2 Percentage Change in Nutrient-Rich Score Associated with a 10 Percent Increase in Diet Cost for Low-Income Individuals, by Major Food Category



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

4. Estimates of the Association between Diet Cost and Nutrient Density for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

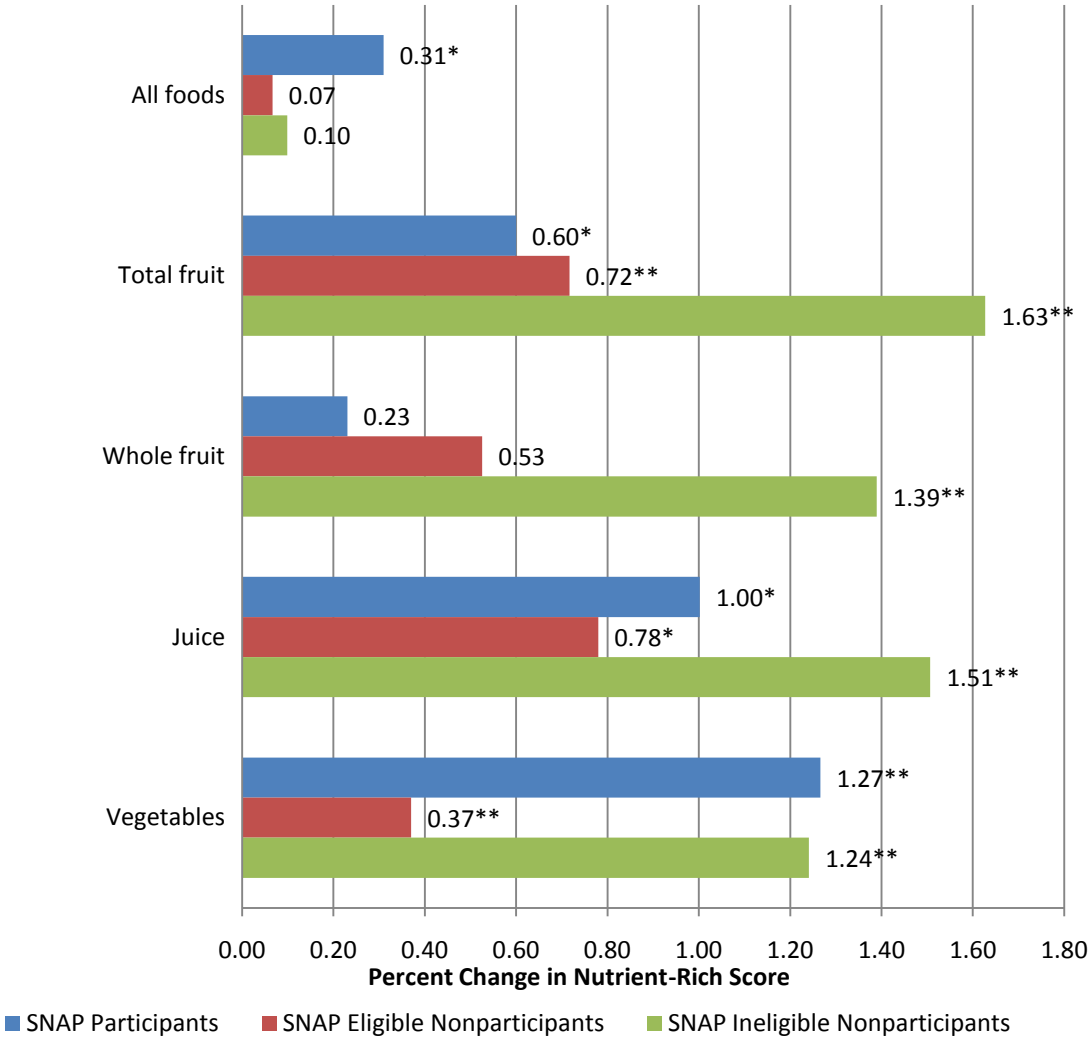
In this section, we present the NHANES results for the same regression estimated using subgroups defined by SNAP participation and eligibility group. Each figure shows whether the associations between diet cost and nutrient-rich scores for selected food subgroups exist for each SNAP participation and eligibility group.

SNAP participants with greater diet cost consume a mix of foods higher in nutrient density overall (Figure VI.3). For eligible and ineligible nonparticipants, there is no observed relationship

between diet cost and nutrient density for all foods taken as whole, although, similar to the results for participants, statistically significant associations exist for several food groups and subgroups.

Turning to the fruit and vegetable subgroups, SNAP participants and both eligible and ineligible nonparticipants with greater diet cost consume fruit that is higher in nutrient density. In addition, only ineligible nonparticipants consume more nutrient-dense whole fruit, the greater the individuals' diet cost. For all three participation and eligibility groups, the greater individuals' diet cost, the higher the nutrient-density of juice consumed. Finally, SNAP participants and both eligible and ineligible nonparticipants with greater diet cost consume more nutrient-dense vegetables.

Figure VI.3 Percentage Change in Nutrient-Rich Scores Associated with a 10 Percent Increase in Diet Cost, by SNAP Participation and Eligibility Status and by All Food and Fruit and Vegetable Categories

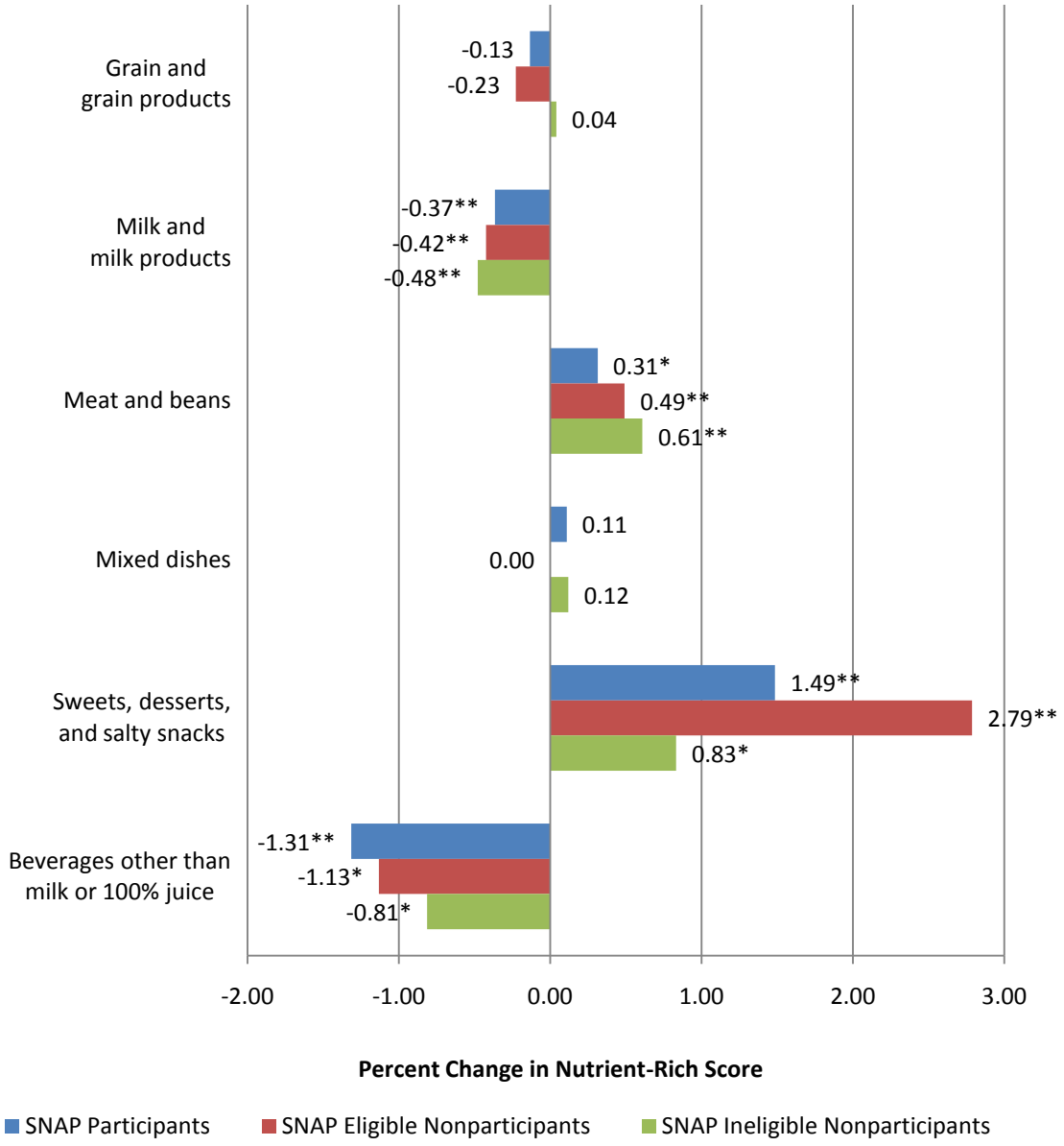


Source: 2001–2004 NHANES appended with price data
Universe: Individuals with income under 300 percent of poverty.
Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

For all three groups, individuals with greater diet cost consume on average more nutrient-dense meat and beans and sweets, desserts, and salty snacks, and less nutrient-dense milk and milk products (Figure VI.4). For each of these three food subgroups, the relationship for SNAP

participants differs from the relationship for eligible nonparticipants. For example, a 10 percent increase in diet cost is associated with a -0.42 percent decrease in eligible nonparticipants' nutrient-rich score for milk and milk products, but only a -0.37 percent decrease in the score for SNAP participants.

Figure VI.4 Percentage Change in Nutrient-Rich Scores Associated with a 10 Percent Increase in Diet Cost, by SNAP Participation and Eligibility Status and by Major Food Category Excluding Fruits and Vegetables



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

The findings from the NHANES support those from the NFSPS analyses, namely that SNAP participants consume more nutrient-dense foods the greater the cost of the individuals' diets. While this correspondence exists overall for all foods, only in the NHANES data do participants with greater diet cost consume more nutrient-dense fruits and vegetables.

While the analyses based on the NFSPS and NHANES are similar, several important differences between the two data sets warrant caution in comparing results. First, the unit of observation is the household in the NFSPS and the individual in the NHANES. Second, the recall period is seven days for food use in the NFSPS and one day for food consumption in the NHANES. Third, the NFSPS data were obtained in 1996, whereas the NHANES data are from 2001-2004.

It is difficult to identify how these differences might affect the results. For example, the household more closely resembles a SNAP unit, providing a more appropriate context with which to evaluate the expenditure/diet quality association among SNAP participants. However, having the household as the unit of analysis may also weaken the ability to obtain an estimate of this association that is not dependent on other factors such as household composition.[48] In addition, the complicated system relating household and individual consumption preferences, budget decisions, nutrition knowledge, food prices, and food purchase locations may have been altered by changing economic conditions, public policy, and cultural norms between the 1996 and 2001-2004 survey periods. These differences should be considered when synthesizing results from the two sets of analyses.

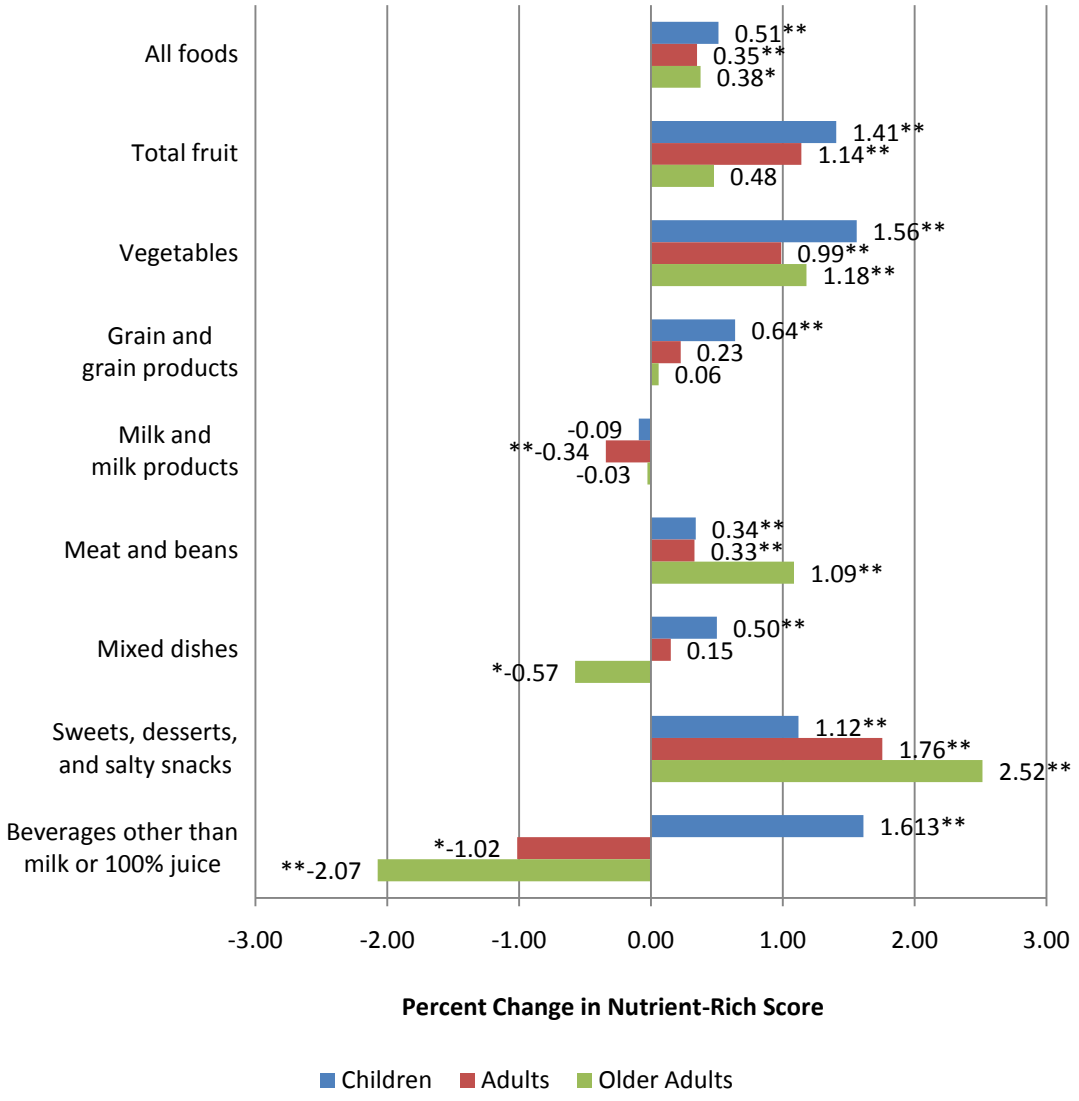
5. Estimates of the Association Between Diet Cost and Nutrient Density for Other Demographic and Economic Subgroups

In this section, we present the NHANES results for the same regression estimated using subgroups defined by demographic and economic characteristics (other than SNAP participation and eligibility). Each figure shows whether the associations between diet cost and nutrient density exist for each subgroup.

Figure VI.5 presents the associations between diet cost and nutrient-rich scores for selected food subgroups by age group. Low-income children and adults with greater diet cost consume more nutrient-dense fruits. This relationship is not present for older adults. In addition, children with greater diet cost consume grains and grain products with higher nutrient density. Finally, children with greater diet cost consume more nutrient-dense mixed dishes, while older adults with greater diet cost consume less nutrient-dense mixed dishes.

[48] To address possibility of an "omitted variables" problem related to household composition, we included several measures related to the presence of multiple adults, children, and elderly members of the household and also accounted for differences across households in the number of AMEs.

Figure VI.5 Percentage Change in Nutrient-Rich Scores Associated with a 10 Percent Increase in Diet Cost, by Age and by Major Food Category



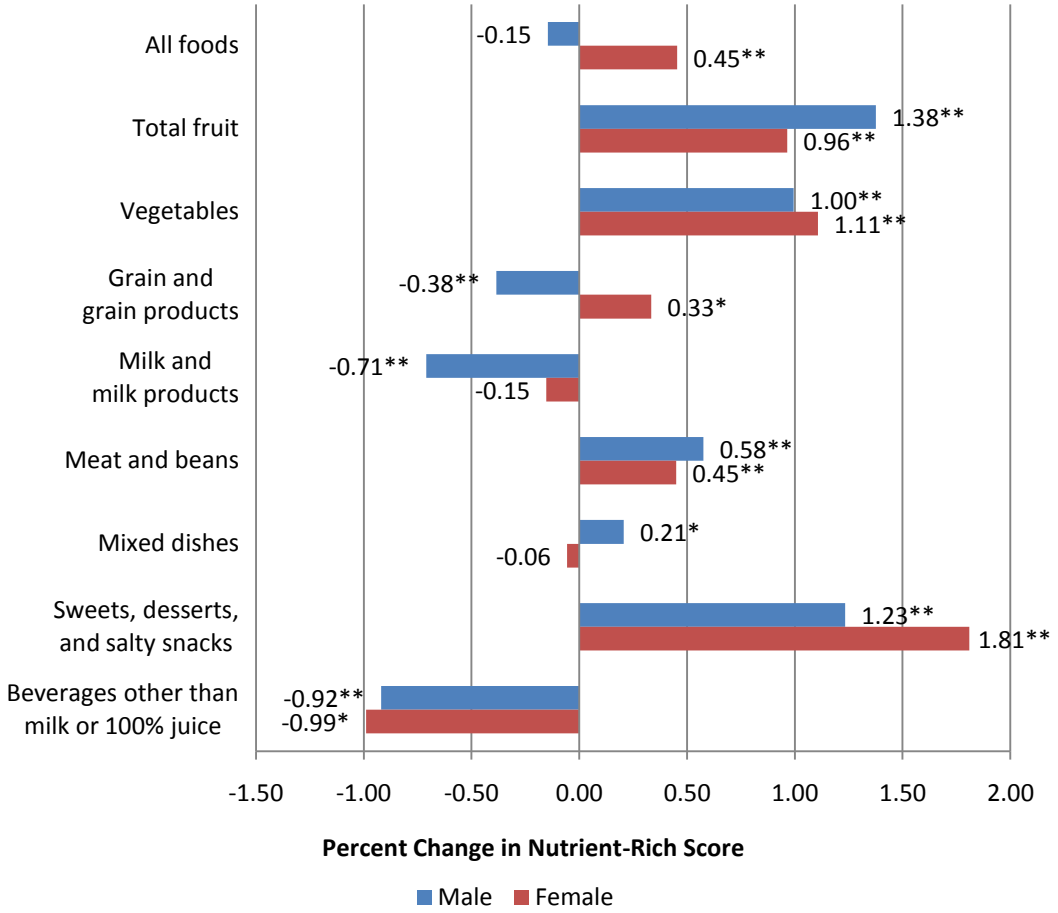
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure VI.6 shows the estimation of this relationship by gender. Overall, low-income females with greater diet cost consume a more nutrient-dense mix of foods, but there is no association for males. However, both sets of individuals consume fruits and vegetables with higher nutrient density, the greater the cost of individuals' diets.

Figure VI.6 Percentage Change in Nutrient Density Associated with a 10 Percent Increase in Diet Cost, by Gender and by Major Food Category



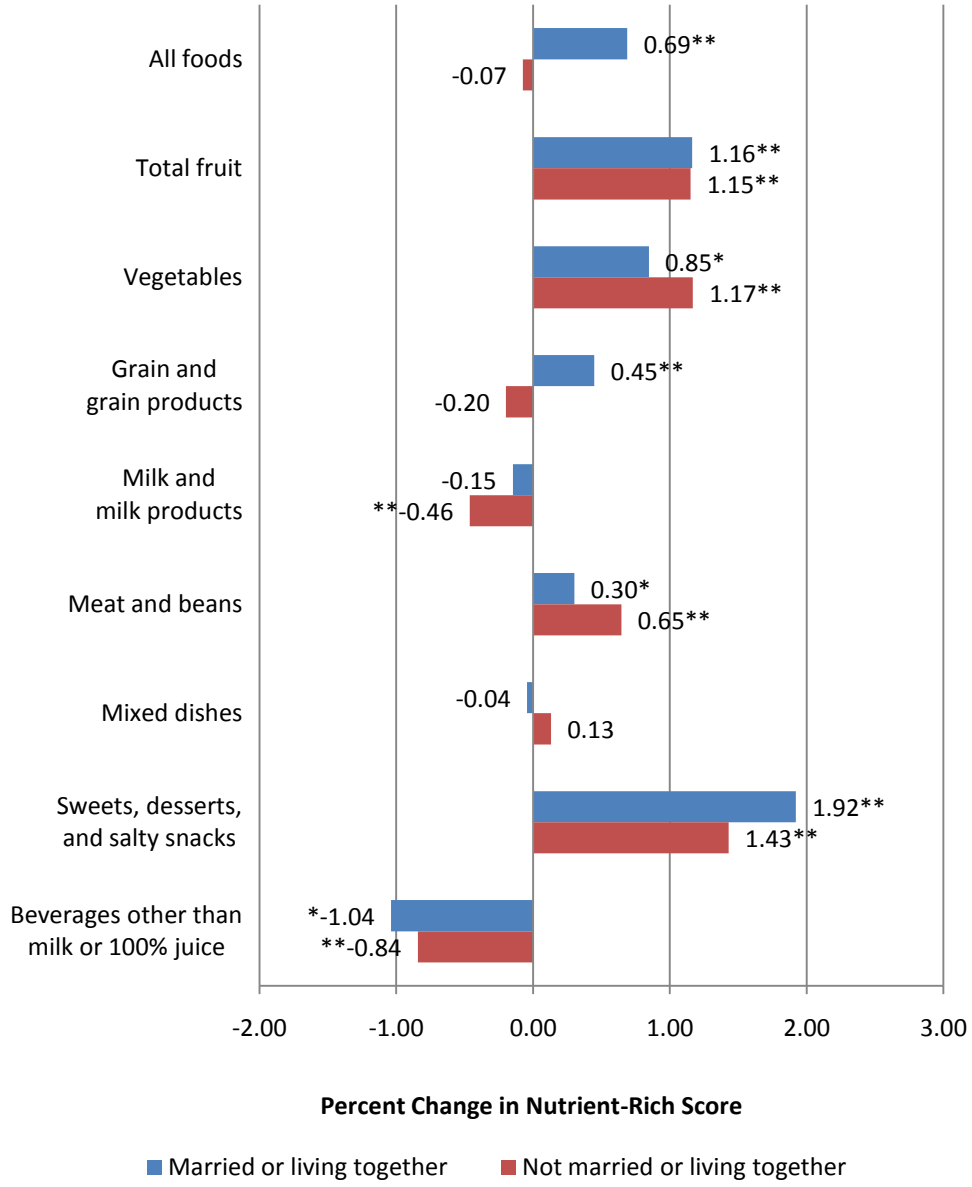
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Individuals who are married or living together and have greater diet cost consume more nutrient-dense foods overall, but there is no association for individuals who are not married or not living together (Figure VI.7). The same is true for the consumption of grains and grain products. However, both sets of individuals consume fruits and vegetables with higher nutrient density, the greater the cost of individuals' diets.

Figure VI.7 Percentage Change in Nutrient Density Associated with a 10 Percent Increase in Diet Cost, by Marital or Living Together Status and by Major Food Category



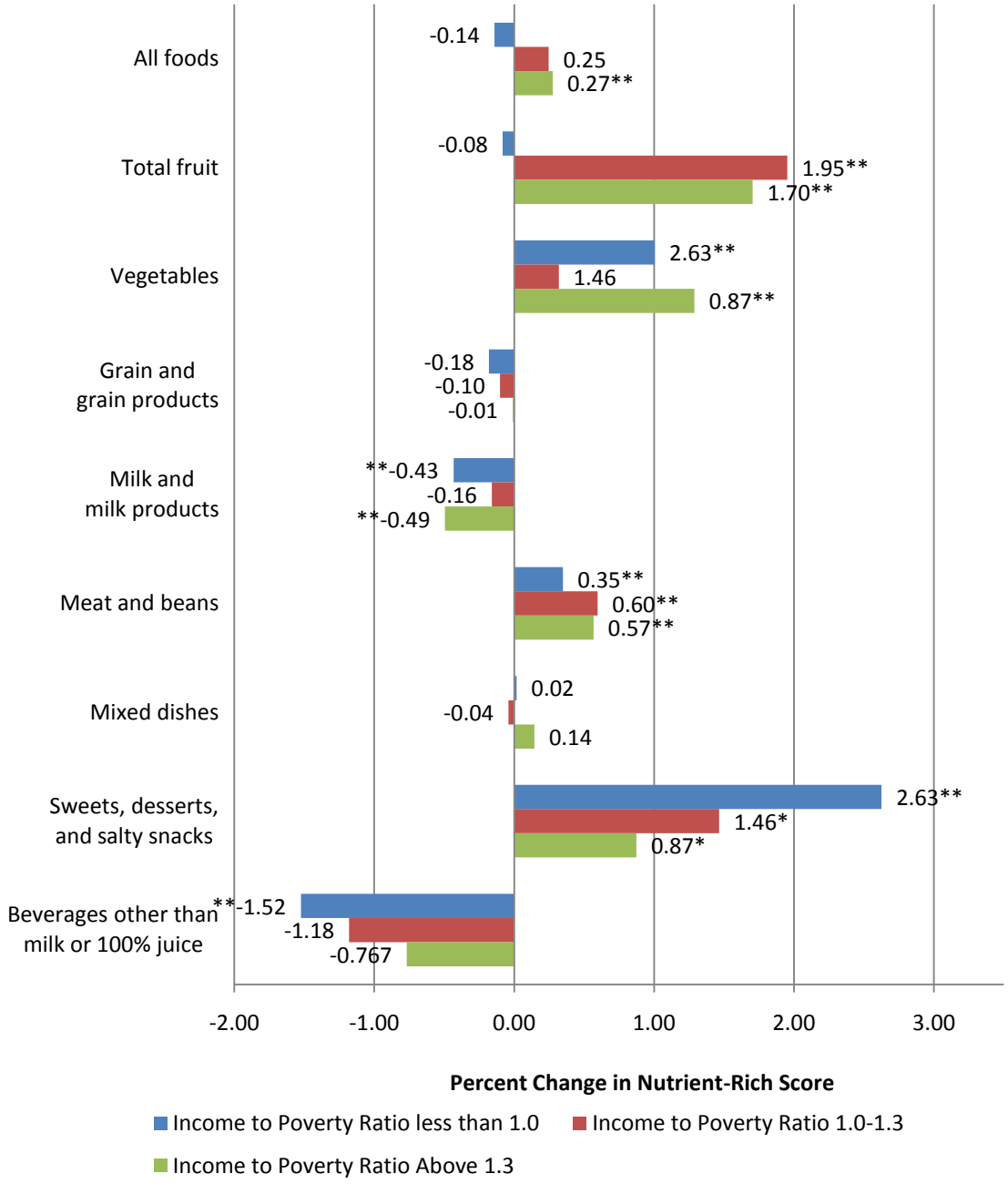
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Only low-income individuals with income greater than 130 percent of poverty consume an overall mix of foods with higher nutrient density, the greater the diet cost (Figure VI.8). There is no relationship for all foods between diet cost and nutrient density for individuals with lower income. However, individuals with income greater than or equal to 100 percent of poverty with greater diet cost consume more nutrient-dense fruits. Finally, for all income groups, greater diet cost is associated with consuming more nutrient-dense sweets, desserts, and salty snacks. This association is strongest for individuals with the lowest level of income.

Figure VI.8 Percentage Change in Nutrient Density Associated with a 10 Percent Increase in Diet Cost, by Income and by Major Food Category



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

VII. RELATIVE CONTRIBUTION OF SPECIFIC FOODS TO MYPYRAMID GROUPS AND OTHER DIETARY COMPONENTS

The final measure of diet quality using the NFSPS and NHANES data captures the relative contribution of specific foods to the use/intake of MyPyramid groups (fruit; vegetables; grains; milk; meat and beans; and oils).[49] We also examine food sources of three other dietary components included in the Healthy Eating Index-2005 (HEI-2005)—saturated fat, sodium, and calories from SoFAAS (solid fat, alcohol, and added sugar). As in the HEI-2005 analyses presented in Chapter III, analyses are based on foods at the component or ingredient level. That is, a single food may contribute to multiple MyPyramid groups. For example, pizza contributes to the grain group (crust), vegetable group (tomato sauce and any other vegetables), and the milk group (cheese), and depending on the ingredients, pizza may also contribute to the meat and beans group.

The analysis in this chapter involves estimating "food shares," or the proportion of MyPyramid group or other dietary component that is provided by various foods. As in other chapters, descriptive tables are presented and comparative analysis is undertaken. Somewhat different approaches are used in the descriptive tables and in the analysis of the effects of expenditures (or diet cost) on food shares. For the descriptive tables we draw on methods by Krebs-Smith et al. (1992) and later expanded by Subar and colleagues (1998a, 1998b). They found that in developing nutrition-related descriptive information based on calculated population proportions, it appeared best to calculate the numerators and the denominators for an entire population and then to take the ratio of these two quantities, rather than taking the average of ratios for the individual observations. To be sure, much of this methodological work has been done in the context of Healthy Eating Index indicators and is therefore not directly related to the "food shares" being examined in this chapter. Nevertheless, while we are not aware of any work extending the approach to food "shares," we believe that it is reasonable to extend this methodology to our descriptive work here.

To implement this approach in the descriptive tables here, population-based proportions were calculated on our sample to estimate the relative contribution of specific groups of foods to each MyPyramid group and dietary component examined. This was done by summing the weighted amounts of MyPyramid groups, for example cup equivalents in the milk group, provided by a specific subgroup of foods such as fluid milk or cheese, for all households or individuals in the sample and dividing by the total weighted amount of the MyPyramid group in the foods used by NFSPS households or consumed by all individuals in NHANES. Weights were taken from the observation weights on the NHANES and NFSPS data files.

For analytic work to examine the association of expenditures on food shares (in the NFSPS) or diet cost on food shares (in the NHANES), we considered dividing the population into high-expenditures versus low-expenditures analysis groups and then comparing the relevant population food distributions in the two groups. This could have been analogous to the descriptive "population ratio" approach outlined in the previous paragraph. However, it was not clear that the sample size in the NFSPS would have supported this research, particularly when population subgroups were

[49] In the NFSPS analysis, we examine the contribution of foods used by households over a seven-day period to MyPyramid groups and other dietary components. In analysis of the NHANES data, we examine the contribution of food sources to individuals' intake of MyPyramid groups and other dietary components in a 24-hour period.

examined. Also, we were mindful that the methodological work on using population ratios was based of descriptive analysis and it is not clear whether the benefits of the approach noted for the descriptive analysis necessarily carried over to examining associations of variables. Therefore, in analyzing associations between food shares and expenditures, we have based our work on multivariate analyses at the individual level. We believe that any biases that exist within estimates for individual groups are likely to largely cancel out in the cross-group comparisons.

In implementing this analysis, we estimate the association between food expenditures and the relative contribution of specific foods to MyPyramid groups defined for each household rather than the population proportions presented in the descriptive tables. Proportions are calculated at the household (rather than population) level by summing across all of the food used by the household in the seven-day study period. We follow the same convention for the NHANES data set, but we sum across all food used by an individual in a 24-hour period. This is similar to the methodological framework used to analyze HEI-2005 scores in Chapter III. We use household-level contributions of specific foods to MyPyramid groups in the NFSPS (and individual-level contributions in the NHANES) to estimate regressions of the association between these contributions and (1) expenditures in the NFSPS and (2) diet cost in the NHANES.

We find the following relationships between food expenditures or diet cost and the relative contribution of specific foods to MyPyramid groups. Overall, the magnitudes of these associations appear to be small.

- SNAP participant households who spend more on food, relative to those who spend less, obtain a larger share of total fruit from whole fruit (canned, frozen, dried, etc.); a larger share of total milk made of up yogurt and cheese; a larger share of total grains from whole grain foods and from sweets and salty snacks; and a larger share of meat and beans from peanut butter, nuts, and seeds. They also obtain a larger share of both discretionary solid fat and saturated fat from sweets and desserts than those who spend less.

- Low-income individuals with higher diet cost, relative to those with lower diet cost, consume larger shares of total fruit from whole fruit and 100 percent fruit juice, and smaller shares from other foods such as syrups, jellies, and jams; smaller shares of total milk from fluid milk and larger shares from yogurt and cheese; smaller shares of total grains from non-whole grains and larger shares of total grains from mixed dishes, sweets and salty snacks, and other foods; and larger shares of meat and beans from meat, poultry, and fish; eggs; peanut butter, nuts, and seeds; soybean products; and other foods.

- SNAP participants, eligible nonparticipants and ineligible nonparticipants with higher diet costs consume larger shares of total fruit from whole fruit. However, only SNAP ineligible nonparticipants with higher diet costs consume larger shares of total fruit from 100 percent fruit juice than those with lower diet costs.

- SNAP eligible and ineligible nonparticipants with higher diet costs consume smaller shares of total milk from fluid milk. However, only SNAP participants with higher diet costs consume larger shares of total milk from whole milk and smaller shares from skim milk than those with lower diet costs. In fact, eligible nonparticipants with higher diet costs consume smaller shares of total milk from whole milk. This is also reflected in the share of saturated fat from milk and milk products. SNAP participants with higher diet cost consume larger shares of saturated fat from milk and milk products than those with lower diet costs. This result is not present for eligible and ineligible nonparticipants.

- SNAP eligible and ineligible nonparticipants with higher diet costs consume smaller shares of total grains from grains and grain products. Additionally, only SNAP eligible nonparticipants with higher diet costs consume smaller shares of total grains from non-whole grains than those with lower diet costs. The association with whole grains is not significant for any SNAP participation and eligibility group.

The chapter begins with a description of the relative contribution of specific foods to MyPyramid groups among SNAP participant households in the NFSPS. This is followed by a summary of findings from multivariate analyses that examined whether households that spend more on food obtain smaller or larger shares of their MyPyramid groups from specific types of food. The chapter then turns to discussion of the NHANES data, in which we examine whether individuals with greater diet cost obtain smaller or larger shares of their MyPyramid groups from specific types of food.

A. Food Sources of MyPyramid Groups, Saturated Fat, Sodium, and Calories from SoFAAS in Foods Used by SNAP Households

Tables VII.1 through VII.4 summarize the relative contribution of specific foods to MyPyramid groups and other dietary components included in HEI-2005 scores among SNAP participant households in the NFSPS. Key findings are summarized briefly below.

Table VII.1 Relative Percentage Contribution of Specific Foods to Availability of MyPyramid Food Group Equivalents for Fruit, Vegetables, and Milk

MyPyramid Group	Percent Contribution	MyPyramid Group	Percent Contribution
Fruit			
100% Fruit Juice	**32.5**	**Other Foods**	**7.3**
Fruit	**60.1**	Juice drinks and other sweetened beverages	3.9
Fresh fruit	56.2	Syrup, jellies, and jams	0.6
Canned fruit	2.7	Baked desserts	0.8
Fruit canned in water or juice	1.0	RTE cereals	0.2
Fruit canned in syrup	1.7	Other foods	1.8
Dried/frozen fruit	0.7		
Baby food	0.5		
Vegetables			
Vegetables	**85.9**	**Other Foods**	**14.1**
Fresh vegetables	53.2	Potato chips	6.8
Canned or frozen vegetables	31.6	Condiments/cooking ingredients	1.1
Vegetables, form not specified	1.0	Pizza	1.4
Baby food	0.2	Spaghetti and other pasta-based dishes	0.5
		Other frozen, carry-out, and deli-prepared foods	2.2
French fries and other fried potatoes[a]	2.2		
Other potatoes (not fried)[a]	18.1		
Other starchy vegetables[a]	10.8		
Tomatoes/tomato sauce[a]	8.7		
Dark green and deep yellow vegetables[a]	11.9		
Other (includes green beans, green and red peppers, iceberg lettuce, onions, zucchini, and cucumbers)[a]	34.2		

Table VII.1 (*continued*)

MyPyramid Group	Percent Contribution	MyPyramid Group	Percent Contribution
		Milk	
Fluid Milk	**70.8**	**Cheese**	**19.9**
Flavored	1.0	Regular	18.6
Unflavored	64.0	Lowfat or fat-free	1.4
Infant Formula	5.7		
Whole	43.9	**Other Foods**	**8.0**
2%	11.0	Pudding, frozen yogurt, and ice cream	3.4
1%	5.9	Milk/cocoa drinks	0.4
Skim	4.2	Macaroni and cheese and other pasta-based dishes	0.2
Yogurt	**1.2**	Pizza	2.4
Whole milk	0.0	Other	1.7
Lowfat or fat-free	1.2		

Source: 1996 NFSPS data
[a] Excludes baby food.

Fruit Group

Among SNAP households, fruit—fresh, canned, frozen, dried, and baby food—was the most important source of total fruit. Fruit contributed almost twice as much of the total fruit equivalents used by SNAP households over seven days than juice (60 percent versus 33 percent) (Table VII.1). Other foods, including juice drinks, syrups, jellies and jams, baked desserts, and ready-to-eat cereals made relatively minor contributions to the MyPyramid fruit group (7 percent). Fresh fruit was the leading source of fruit by a wide margin (56 percent versus 3 percent for canned fruit and less than 1 percent for dried fruit and baby food fruit).

Vegetable Group

Discrete vegetables were the leading contributor to the vegetable group (86 percent) (Table VII.1). Mixed dishes and other foods, such as pasta-based dishes and potato chips, made substantially smaller contributions to MyPyramid vegetable group (14 percent). Among the vegetables used by SNAP households, fresh vegetables made the greatest contribution to the vegetable group (53 percent), followed by canned or frozen vegetables (32 percent). White potatoes (not fried) were the leading single contributor to the vegetable group (18 percent). Among other foods that contributed to the vegetable group, the leading source was potato chips (7 percent).

Milk Group

Fluid milk accounted for close to three-quarters (71 percent) of the total milk group used by SNAP households over seven days (Table VII.1). Whole milk made the greatest contribution to the milk group (43 percent). This is twice the relative contribution of reduced-fat, lowfat, and skim milk combined (11, 6, and 4 percent, respectively). Cheese was the next leading contributor, but accounted for only about 20 percent of the total milk that was used by SNAP households. Yogurt made a small contribution (1 percent) to total milk, and other foods, including pudding and pizza, contributed about 8 percent.

Table VII.2 Relative Contribution of Specific Foods to Availability of MyPyramid Food Group Equivalents for Grain and Grain Products and Meat and Beans

MyPyramid Group	Percent Contribution	MyPyramid Group	Percent Contribution
Grains and Grain Products			
Grains and Grain Products	**76.5**	**Frozen, Carry-out, Deli-prepared Foods**	**7.0**
Whole grains	5.9	Pizza	1.9
Non-whole grains	70.6	Spaghetti, macaroni and cheese, and other pasta-based mixed dishes	3.0
		Mexican-style entrees	0.2
Breads and rolls	28.2	Sandwiches	0.7
Crackers	4.6	Soups	0.4
Rice	11.7	Other	0.8
Pasta	6.3		
Flour and meals	10.2	**Sweets and Desserts and Salty Snacks**	**14.9**
RTE breakfast cereals	9.1	Cakes, cookies, and brownies	5.9
High sugar	3.6	Pies, doughnuts, pastries, muffins, and biscuits	5.7
Not high in sugar	5.5	Salty snacks	3.0
Pancakes, waffles, and French toast	1.5	Other	3.4
Infant cereals	0.4		
Other	4.5	**Other Foods**	**1.6**
Meat and Beans			
Meat, Poultry, and Fish	**82.9**	Organ meats	1.0
Lean	18.6	Lean	0.8
Higher-fat	64.3	Higher-fat	0.2
Beef	25.9	Poultry	20.1
Lean	1.8	Lean	7.0
Higher-fat	24.0	Higher-fat	13.1
Pork/ham	15.0	Fish	8.0
Lean	0.2	High in Omega-3 fatty acids	2.1
Higher-fat	14.7	Low in Omega-3 fatty acids	5.9
Lamb, veal, and game	0.6		
Lean	0.5	**Eggs**	**5.5**
Higher-fat	0.0	**Dried Beans and Peas**	**5.1**
Sausages, cold cuts, and frankfurters	12.3	**Peanut Butter, Nuts, and Seeds**	**3.6**
Lean	0.5	**Soybean Products/Meat Substitutes**	**0.1**
Higher-fat	11.8	**Other Foods**	**2.8**

Source: 1996 NFSPS data

Grain Group

Three quarters of the total grains used by SNAP households came from grains and grain products, such as bread and rolls (28 percent), rice (12 percent), and flour and meals (10 percent) (Table VII.2). A small proportion of total grains were provided by whole grain foods. Sweets, desserts, and salty snacks accounted for 15 percent of total grains, and prepared foods (frozen, carry-out, or deli-prepared foods) accounted for 7 percent of total grains.

Meat and Beans Group

Meat, poultry and fish used over the course of a week by SNAP households were the largest contributor to the meat and beans group (83 percent) (Table VII.2). Meat alternates made

substantially smaller contributions—eggs and beans each contributed about 5 percent and peanut butter, nuts, and seeds contributed about 4 percent. Higher-fat varieties of meat, poultry, and fish used by SNAP households contributed to a larger share of the meat and beans group than did leaner versions (64 percent versus 19 percent). Beef was the leading contributor to this MyPyramid group (26 percent), followed by poultry (20 percent), pork/ham (16 percent), and sausages, cold cuts, and frankfurters (12 percent). Fish provided only 8 percent of the meat and bean group.

Table VII.3 Relative Contribution of Specific Foods to Availability of MyPyramid Food Group Equivalents for Discretionary Oils, Saturated Fat, and Sodium

MyPyramid Group	Percent Contribution	MyPyramid Group	Percent Contribution
Discretionary Oils			
Fats and Oils	**74.0**	**Meats and Beans**	**9.2**
Vegetable oils	46.8	Peanut butter, nuts, and seeds	8.2
Salad dressings, mayonnaise	18.1	**Vegetables**	**1.6**
Margarine	9.0	**Sweets and Desserts**	**1.1**
Salty Snacks	**12.6**	Cookies, cakes, and brownies	0.4
Potato chips	10.0	Candy	0.4
Corn, tortilla, and other chips	2.6	**Other Foods**	**1.5**
Saturated Fat			
Meats and Beans	**46.9**	**Sweets and Desserts**	**7.5**
Beef	16.9	Pudding, frozen yogurt, and ice cream	3.0
Pork	10.7	Cakes, cookies, and brownies	2.2
Sausage, cold cuts, and frankfurters	10.3	Pies, doughnuts, pastries, muffins, and biscuits	1.4
Poultry	4.9	**Frozen, Carry-out, Deli Prepared Foods**	**2.8**
Milk and Milk Products	**20.6**	**Grains and Grain Products**	**2.8**
Cheese	7.2	**Salty Snacks**	**2.0**
Milk	13.1	**Other Foods**	**1.4**
Fats and Oils	**16.0**		
Butter	4.5		
Margarine	3.0		
Vegetable oils	3.3		
Sodium			
Meats and Beans	**29.8**	**Vegetables**	**9.0**
Sausage, cold cuts, and frankfurters	13.9	Canned or frozen	8.3
Pork	5.9	**Frozen, Carry-out, Deli Prepared Foods**	**7.2**
Beef	2.4	Pizza	1.9
Grains and grain products	**23.2**	Soups	1.7
Breads and rolls	8.3	Spaghetti, macaroni and cheese, and other pasta-based mixed dishes	1.5
RTE breakfast cereals	1.4	Other	2.1
Flour and meals	3.1	**Sweets and Desserts**	**5.9**
Pasta	6.1	**Fats and Oils**	**5.7**
Milk and Milk Products	**10.6**	Margarine	2.5
Cheese	5.4	Salad dressings, mayonnaise	1.9
Milk	4.8	**Condiments and Spices**	**5.0**
		Other Foods	**3.8**

Source: 1996 NFSPS data

Oils

The leading sources of oils in the foods used by SNAP households were fats and oils, including vegetable oils (47 percent), salad dressings and mayonnaise (18 percent), and margarine (9 percent)

(Table VII.3). Additional sources of oils included salty snacks, particularly potato chips (13 percent) and peanut butter, nuts, and seeds (8 percent).

Saturated Fat

Almost half (47 percent) of all saturated fat in the foods used by SNAP households came from meats and beans (Table VII.3). Milk and milk products were the next major contributor, accounting for 21 percent of all saturated fat. Added fats and oils, including butter, margarine, and vegetable oils, contributed 16 percent of all saturated fat and sweets and desserts contributed 8 percent.

Sodium

Foods in the meats and beans food group were the largest contributor to sodium among foods used by SNAP households (Table VII.3). Foods in this group contributed 30 percent of sodium overall; sausages, cold cuts, and frankfurters were the leading contributor, accounting for 14 percent of sodium. Grains and grain products (23 percent) and milk and milk products (11 percent) were the next two largest contributors to sodium.

Table VII.4 Relative Contribution of Specific Foods to Availability of MyPyramid Food Group Equivalents for Calories from SOFAAS

MyPyramid Group	Percent Contribution	MyPyramid Group	Percent Contribution
Calories from SOFAAS			
Meats and Beans	**29.8**	**Milk and Milk Products**	**11.4**
Beef	10.1	Milk	6.9
Sausage, cold cuts and frankfurters	8.6	Cheese	4.2
Pork	7.1	**Beverages Other than Milk**	**11.8**
Poultry	2.1	Alcohol	0.4
Sweets and Desserts	**26.4**	Carbonated sodas	6.8
Sugar	10.8	Juice drinks	3.8
Cakes, cookies, and brownies	5.7	**Fats and Oils**	**10.6**
Pies, doughnuts, pastries, muffins and biscuits	2.5	Margarine	3.9
Candy	1.6	Lard and shortening	2.5
Pudding, frozen yogurt, and ice cream	3.4	Butter	2.7
		Grains and Grain Products	**5.8**
		RTE breakfast cereals	2.0
		Breads and rolls	0.9
		Crackers	2.6
		Frozen, Carry-out, Deli Prepared Foods	**2.2**
		Other Foods	**2.0**

Source: 1996 NFSPS data

Calories from SoFAAS

As with saturated fat and sodium, foods in the meats and beans food group were leading source of calories from SoFAAS (Table VII.4). Foods in this group, led by beef, sausages, cold cuts and frankfurters, and pork, contributed 30 percent of calories from SoFAAS. The next leading sources of calories from SoFAAS were sweets and desserts; this group accounted for 26 percent of calories from SoFAAS. Milk and milk products, beverages other than milk (sweetened beverages and alcohol), and added fats and oils each accounted for roughly 11 percent of calories from SoFAAS.

B. Food Expenditures and Relative Contribution of Specific Foods to MyPyramid Groups, Saturated Fat, Sodium, and Calories from SoFAAS in Foods Used by SNAP Households

1. Methodological Approach

To determine the association between food expenditures and the relative contribution of specific foods to MyPyramid groups and other dietary components, we define contributions like those used in the preceding descriptive analysis at the household level. We estimate regressions in which the percentage contribution of specific foods to MyPyramid groups or saturated fat, sodium, and calories from SoFAAS (per household) is the dependent variable and the natural logarithm of total food expenditures is the main independent variable. We estimate a Tobit regression model rather than a standard OLS regression model because, unlike most of the diet quality measures based on the NFSPS, the measure used in this analysis poses a significant methodological problem that prevents one from producing unbiased estimates using an OLS model. The non-trivial proportions of households in the sample that do not use foods that contribute to specific MyPyramid groups may lead to biased estimates using an OLS model (Tobin 1958). The Tobit model accommodates these types of observations in the sample by separating the decision to use a type of food, such as canned fruit, from the decision of how much of the type of food to use given the household has decided to use a positive amount. For a food type that most households use seldom in a week, such as dried or frozen fruit, an OLS regression model relating food expenditures to the percentage contribution of dried or frozen fruit to the MyPyramid fruit group would produce a biased estimate of this association because only a few households use a positive amount of the food. The Tobit model addresses this bias by emphasizing the decision to use the good, rather than how much to use, when the good is used by few households in the sample. As the number of households that use the good increases, the Tobit estimates of the association between food expenditures and the percent contributions converge to the OLS estimates.

Unlike the empirical models used for most of the NFSPS analyses, we do not report the regression coefficients in the summary figures and tables in this chapter. Rather, we use the regression coefficients to compute "marginal effects," or the change in the relative contribution of specific foods such as the proportion of total fruit contributed by canned fruit (in percentage points) resulting from a one percent increase in total food expenditures. As done in prior chapters, we multiply these values by 10 so that they represent the change in the relative contribution of specific foods associated with a 10 percent increase in food expenditures. Given that the mean amount of food expenditures in the sample is equal to $58.47 (per week), a 10 percent increase is approximately equal to $5.85. Thus, an estimate of 0.78 for whole fruit indicates that an increase in food expenditures of $5.85 is associated with an increase of 0.78 percentage points in the share of total fruit made up of whole fruit that is used by a household.

The other explanatory variables in the regression model consist of indicator variables for whether there are multiple adults in the household (relative to having single adult heads), whether there are children in the household, and whether there are elderly members in the household. We also include variables measuring the number of adult male equivalents (AMEs) and the proportion of meals eaten outside the home. Together, these represent the number of Equivalent Nutrient Units (ENUs) within a household and thus serve as an additional measure of household composition that is not accounted for fully in the other household composition variables. In addition, there are variables indicating the race and ethnicity of the household head, the region of the household's residence, and whether a household resides in an urban, suburban, or rural area, as

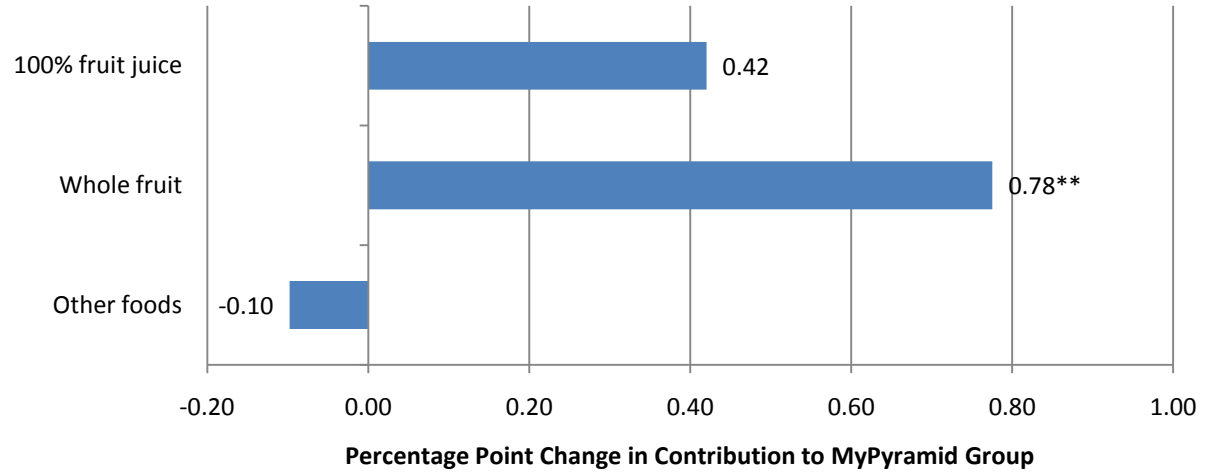
well as several indicator variables related to a household's income relative to the federal poverty threshold. By including these variables in the regression, we are accounting for inter-household differences in these characteristics when estimating the association between expenditures and the relative contribution of specific foods to MyPyramid groups used by households.

Because the Tobit regression coefficients are not as easily interpreted as in a standard OLS regression, we do not discuss the estimates of these characteristics in this section. An example of the output can be found for fresh fruit in Appendix G. The full set of results for the remaining food groups is available from the authors upon request. As in previous chapters, when displaying the results for food categories, we present only on the associations between food expenditures and the contributions to MyPyramid groups.

2. Estimates of the Association between Food Expenditures and the Relative Contribution of Specific Foods to MyPyramid Groups

SNAP participant households who spend more on food obtain a larger share of total fruit from whole fruit (canned, frozen, dried, etc.) than those who spend less (Figure VII.1). A 10 percent increase in spending on food is associated with an increase of 0.78 percentage points in the relative contribution of whole fruit to the MyPyramid fruit group. We do not have a strong basis for determining whether the magnitude of this increase is small or large on a conceptual basis, though compared to the variation of the relative contribution of whole fruit to the MyPyramid fruit group in the sample, it appears to be small.[50] There are no significant associations between expenditures and changes in sources of vegetables (Figure VII.2).

Figure VII.1 Percentage Point Change in Use of Foods that Contribute to MyPyramid Fruit Group Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants

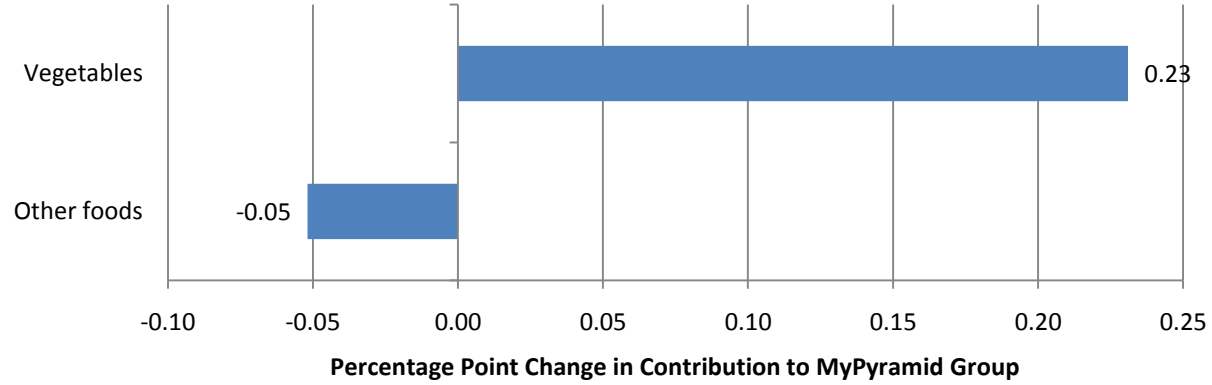


Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

[50] This is based on the ratio of the increase in the mean relative contribution of whole fruit in the sample to the standard deviation of the distribution of relative contributions.

Figure VII.2 Percentage Point Change in Use of Foods that Contribute to MyPyramid Vegetable Group Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants

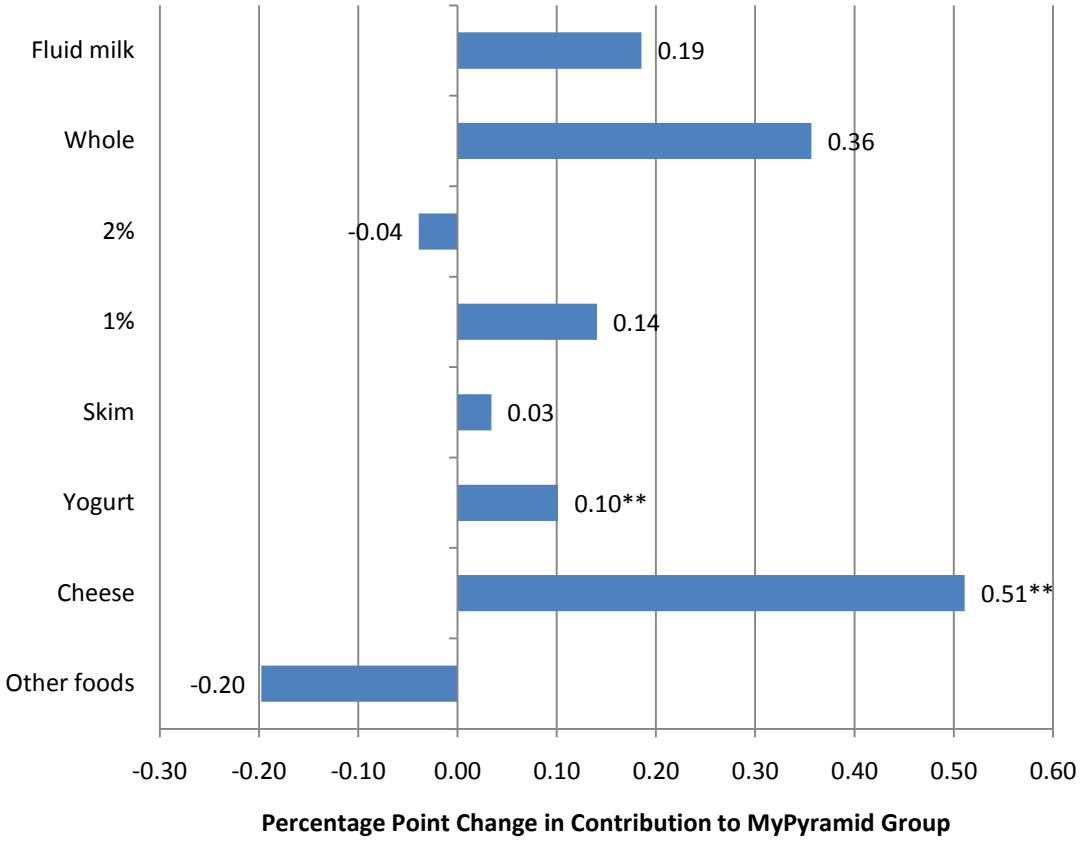


Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

SNAP participant households who spend more on food also have larger shares of total milk made of up yogurt and cheese (Figure VII.3). A 10 percent increase in spending on food is associated with an increase of 0.51 percentage points in the proportion of total milk that is provided by cheese. There were no significant associations between food expenditures and the share of total milk provided by whole, 2 percent, 1 percent, or skim milk.

Figure VII.3 Percentage Point Change in Use of Foods that Contribute to MyPyramid Milk Group Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants

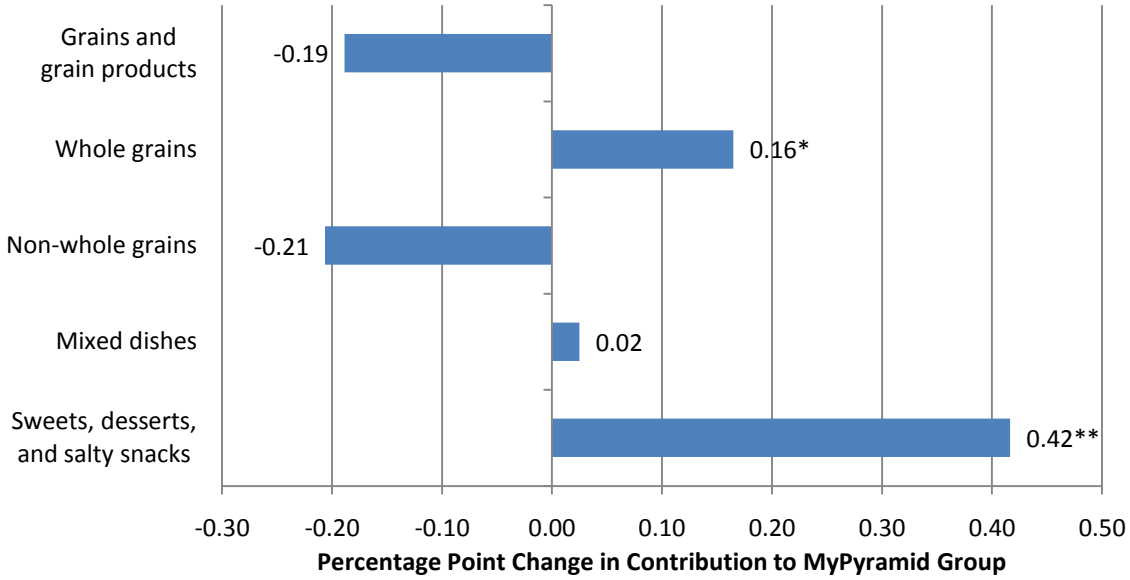


Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

SNAP participant houseohlds who spend more on food obtain a larger share of total grains from whole grain foods than those who spend less (Figure VII.4). They also obtain a larger share of total grains from sweets and salty snacks. Similar results indicate that households with greater food expenditures obtain a larger share of the meats and beans group from peanut butter, nuts, and seeds (Figure VII.5).

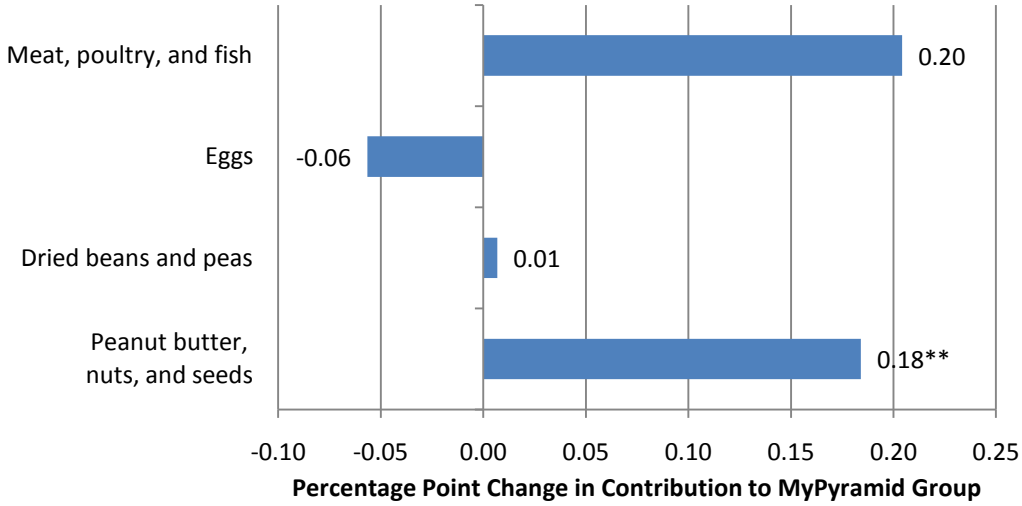
Figure VII.4 Percentage Point Change in Use of Foods that Contribute to MyPyramid Grain Group Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure VII.5 Percentage Point Change in Use of Foods that Contribute to MyPyramid Meat and Beans Group Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants

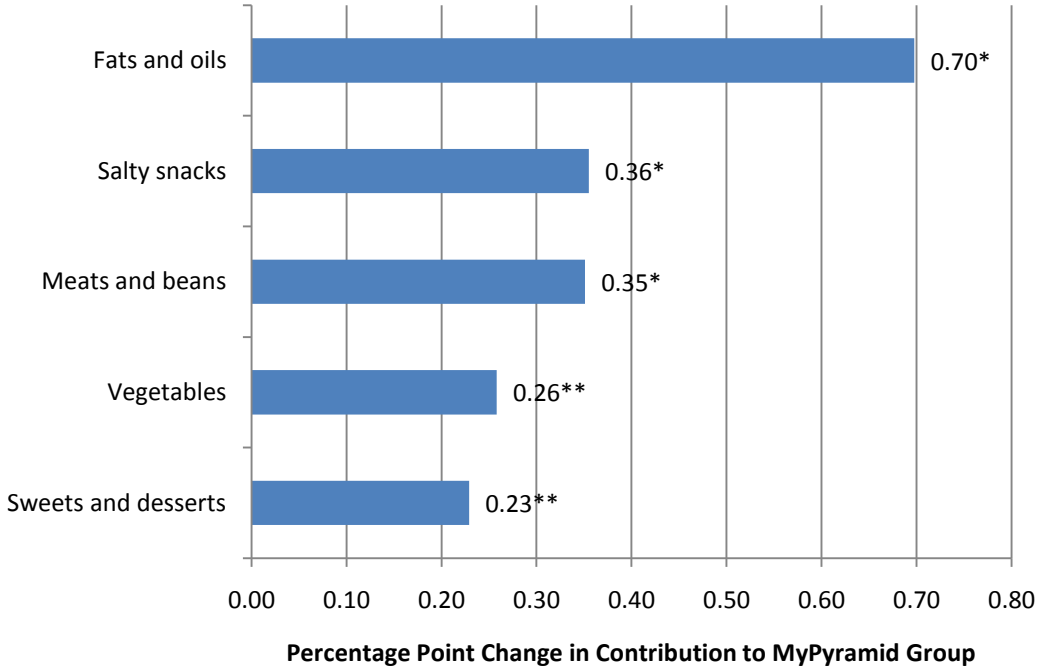


Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

SNAP participant households who spend more on food obtain a larger share of fats and oils from sweets and desserts than those who spend less (Figure VII.6). They obtain more of their discretionary fat from fats and oils, salty snacks, meats and beans, vegetables, and sweets and desserts than those who spend less on food. Similarly, fats and oils, sweets and desserts, and salty snacks contribute a larger share of saturated fat among higher expenditure participant households, than those who spend less on food (Figure VII.7).

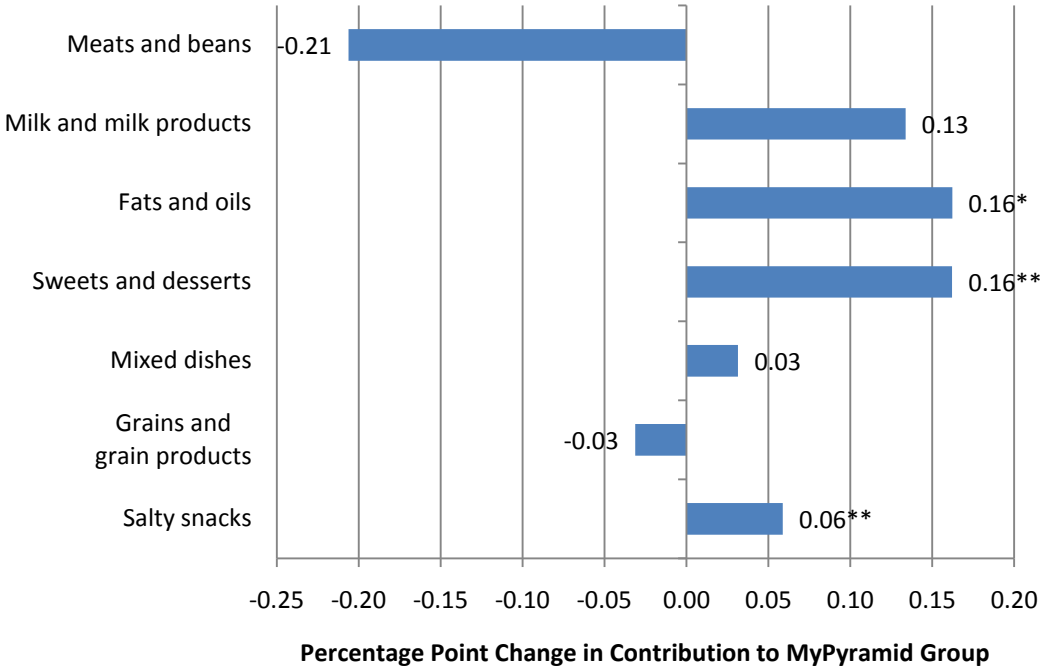
Figure VII.6 Percentage Point Change in Use of Foods that Contribute to Discretionary Solid Fat and Oils Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure VII.7 Percentage Point Change in Use of Foods that Contribute to Saturated Fat Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants

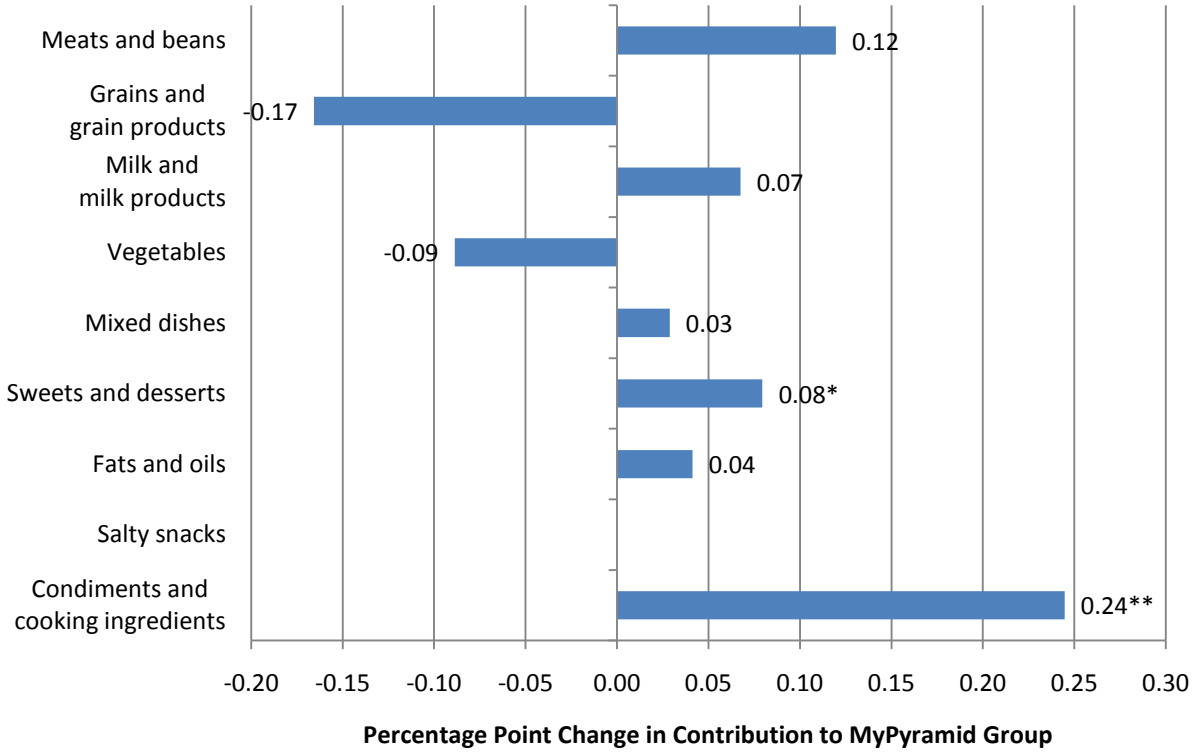


Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

SNAP participant households who spend more on food obtain a larger share of sodium from sweets and desserts and condiments and cooking ingredients (Figure VII.8). Higher expenditure households also obtain larger shares of calories from SoFAAS from sweets and desserts and beverages other than milk and smaller shares from meats and beans and grains and grain products (Figure VII.9).

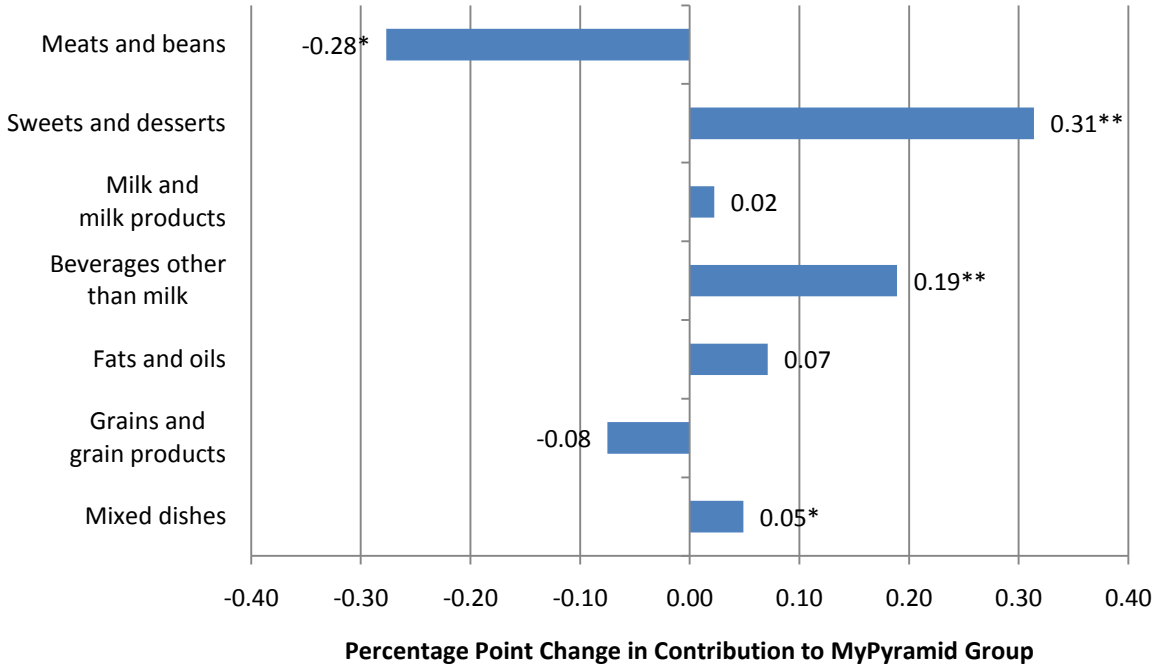
Figure VII.8 Percentage Point Change in Use of Foods that Contribute to Sodium Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Figure VII.9 Percentage Point Change in Use of Foods that Contribute to Calories from SoFAAS Associated With a 10 Percent Increase in Food Expenditures for SNAP Participants



Source: 1996 NFSPS data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

C. Diet Cost and Intake of MyPyramid Food Groups, Saturated Fat, Sodium, and Calories from SoFAAS Among Low-Income Individuals

The analysis in the previous section focused on the relationship between expenditures and the relative contribution of specific foods to MyPyramid groups used by SNAP participant households. Because the sample consisted only of SNAP participants, we could not examine differences in the association by SNAP participation and eligibility status. In this section, we present results from a similar analysis using the NHANES to investigate whether there is a relationship between diet cost and the relative contribution of specific foods to the intake of MyPyramid groups or other dietary components. We also explore whether it differs for subgroups defined by SNAP participation and eligibility status.[51] The NHANES data that we used are limited to sample members with incomes below 300 percent of poverty. The data sets also differ in the unit of observation (household in the NFSPS and individual in the NHANES) and the number of days of available food use or consumption data (seven days in the NFSPS and one day in the NHANES).

[51] Unlike the NHANES analyses in prior chapters, we do not explore whether this relationship differed by household demographic and economic characteristics because of the large number of food groups assessed.

1. Foods Contributing to MyPyramid Groups, Saturated Fat, Sodium, and Calories from SoFAAS in Foods Used by Low–Income Individuals

In Appendix G, we provide tables that summarize the relative contribution of specific food groups to the MyPyramid groups and other dietary components considered in HEI-2005 scores among low income individuals in the NHANES. While the categorization of groups such as fruit, vegetables, and grains and major subgroups such as 100 percent fruit juice and whole fruit for the fruit subgroup is identical to that in the NFSPS, the categorization of minor subgroups is slightly different. As with the NFSPS, we present findings for all major subgroups and for several minor subgroups such as the share of total milk from whole, 2 percent, 1 percent, and skim milk, and the share of total grains from whole grains and non-whole grains.

2. Methodological Approach

The empirical framework is largely the same as in the NFSPS analysis. We estimate Tobit regressions in which the percentage contribution of specific subgroups of foods to MyPyramid food groups or total amounts of saturated fat, sodium, and calories from SoFAAS (per individual), is the dependent variable and the natural logarithm of diet cost is the main independent variable. We multiply the regression coefficient on diet cost by 10 so that it represents the change in contributions associated with a 10 percent increase in diet cost. This is approximately $0.43 per day for the average individual in the NHANES sample (the mean diet cost is $4.28). For example, a coefficient of 0.24 indicates that a $0.43 increase in diet cost is associated with an increase of 0.24 percentage points in an individual's intake of 100% fruit juice as a share of total fruit.

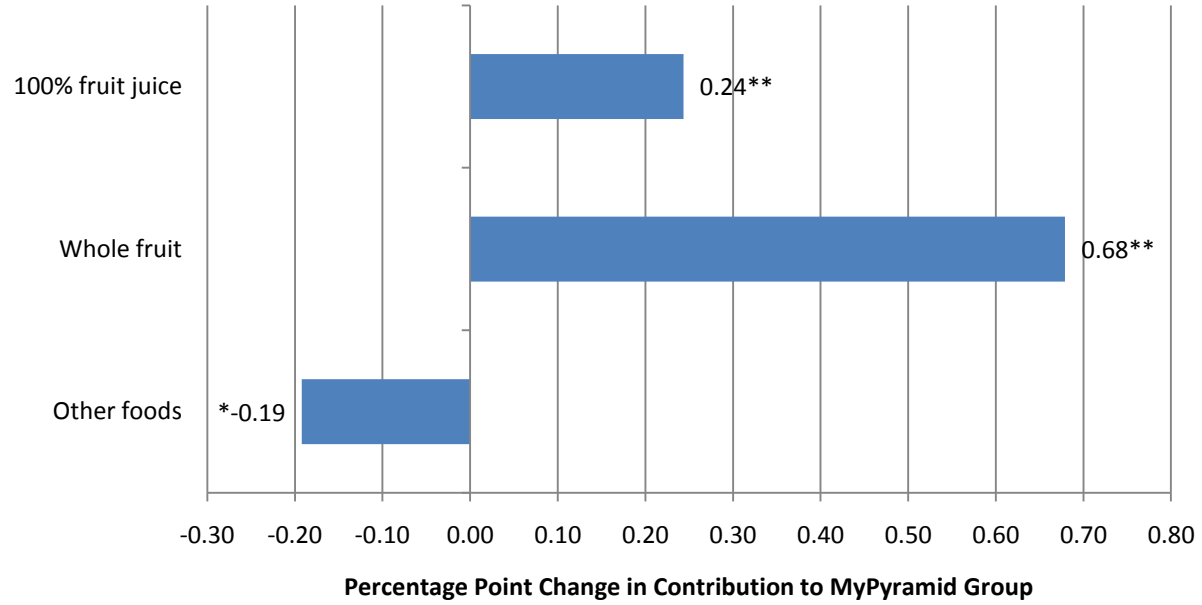
The set of explanatory variables in the regression model differ from those in the NFSPS analysis, in part because the unit of observation is the individual rather than the household. This set consists of SNAP participation and eligibility status, gender, age, race and ethnicity, education, marital status, and income. We estimate the regressions using the full low-income sample and using subsamples defined by SNAP participation and eligibility status.

When presenting these results, we focus only on the associations between diet cost and relative contributions of specific foods to MyPyramid groups and exclude the remaining regression coefficients from the tables and figures. Because of the large number of food groups, we present these coefficients only for fresh fruit in Appendix G. The remaining results are available from the authors.

3. Estimates of the Association Between Diet Cost and the Relative Contribution of Specific Foods to MyPyramid Groups, Saturated Fat, Sodium, and Calories from SoFAAS

Low-income individuals with higher diet cost consume larger shares of total fruit from whole fruit and 100 percent fruit juice, and smaller shares from other foods such as syrups, jellies, and jams than those with lower diet cost (Figure VII.10). A 10 percent increase in diet cost is associated with an increase of 0.68 percentage points in the share of total fruit consumed from whole fruit. Low income individuals with higher diet cost also consume larger shares of total vegetables from vegetables (as opposed to from mixed dishes and other foods that make up total vegetables) (Figure VII.11).

Figure VII.10 Percentage Point Change in Intake of Foods that Contribute to MyPyramid Fruit Group Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals

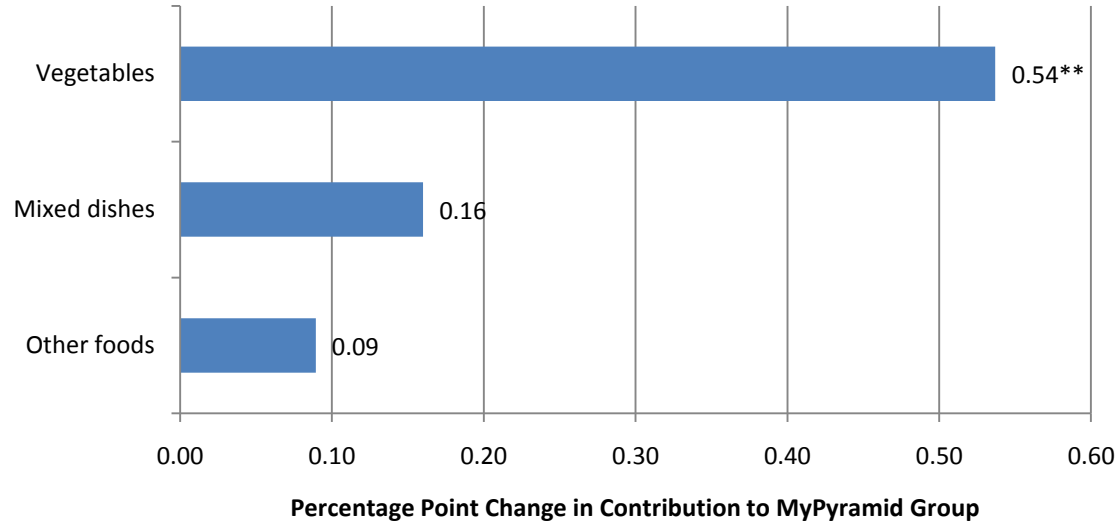


Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure VII.11 Percentage Point Change in Intake of Foods that Contribute to MyPyramid Vegetable Group Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals



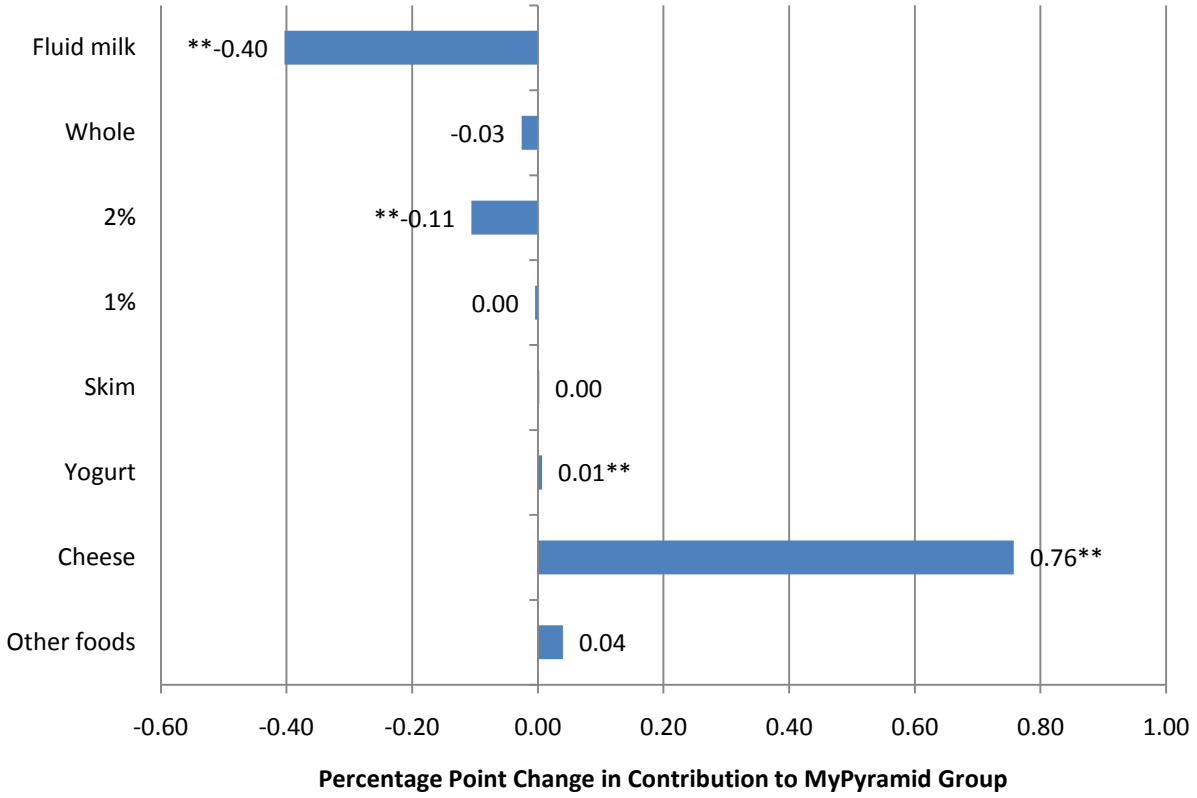
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Low-income individuals with higher diet cost also consume smaller shares of total milk from fluid milk and larger shares from yogurt and cheese (Figure VII.12). A 10 percent increase in diet cost is associated with a decrease of 0.40 percentage points in the proportion of an individual's total milk intake provided by fluid milk. When examining milk by fat content, the results indicate that individuals with higher diet cost consume less 2 percent milk as a share of total milk relative to lower diet cost individuals.

Figure VII.12 Percentage Point Change in Intake of Foods that Contribute to MyPyramid Milk Group Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals



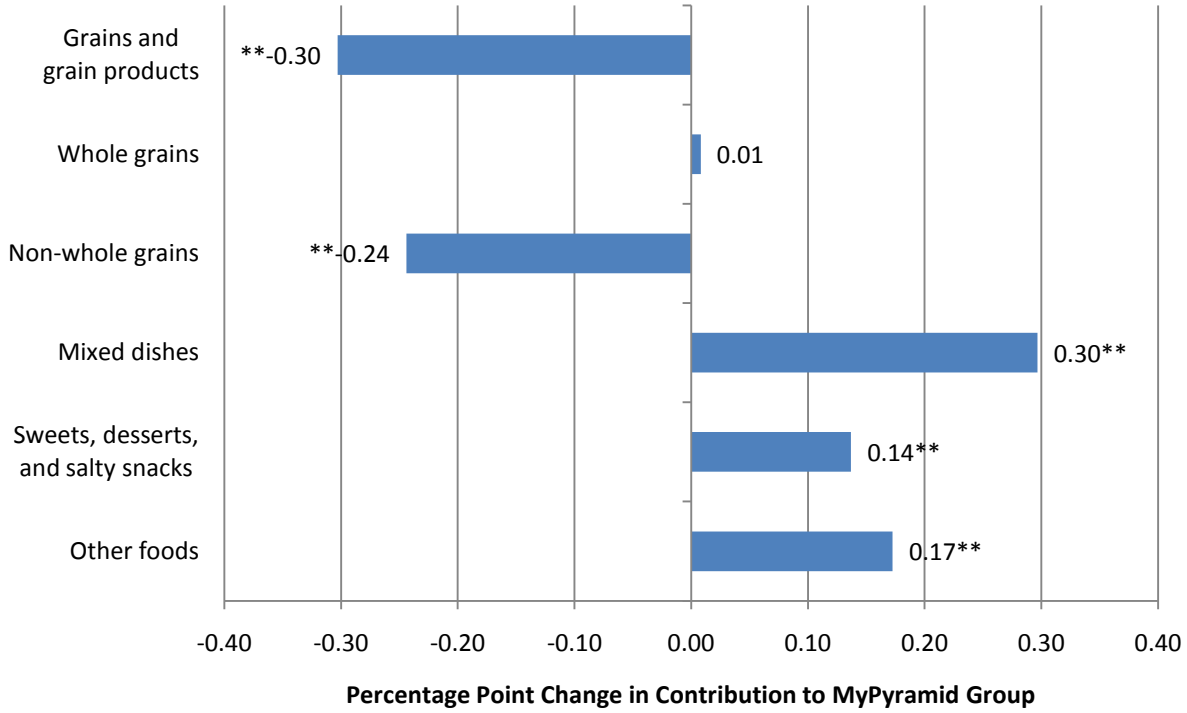
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Low-income individuals with higher diet cost consume a smaller share of total grains from non-whole grains than those with lower diet cost (Figure VII.13). They also consume larger shares ot total grains from mixed dishes, sweets and salty snacks, and other foods. The results in Figure VII.14 indicate that low-income individuals with higher diet cost consume larger sharse of meats and beans from meat, poultry, and fish; eggs; peanut butter, nuts, and seeds; soybean products; and other foods, relative to lower diet cost individuals.

Figure VII.13 Percentage Point Change in Intake of Foods that Contribute to MyPyramid Grain Group Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals

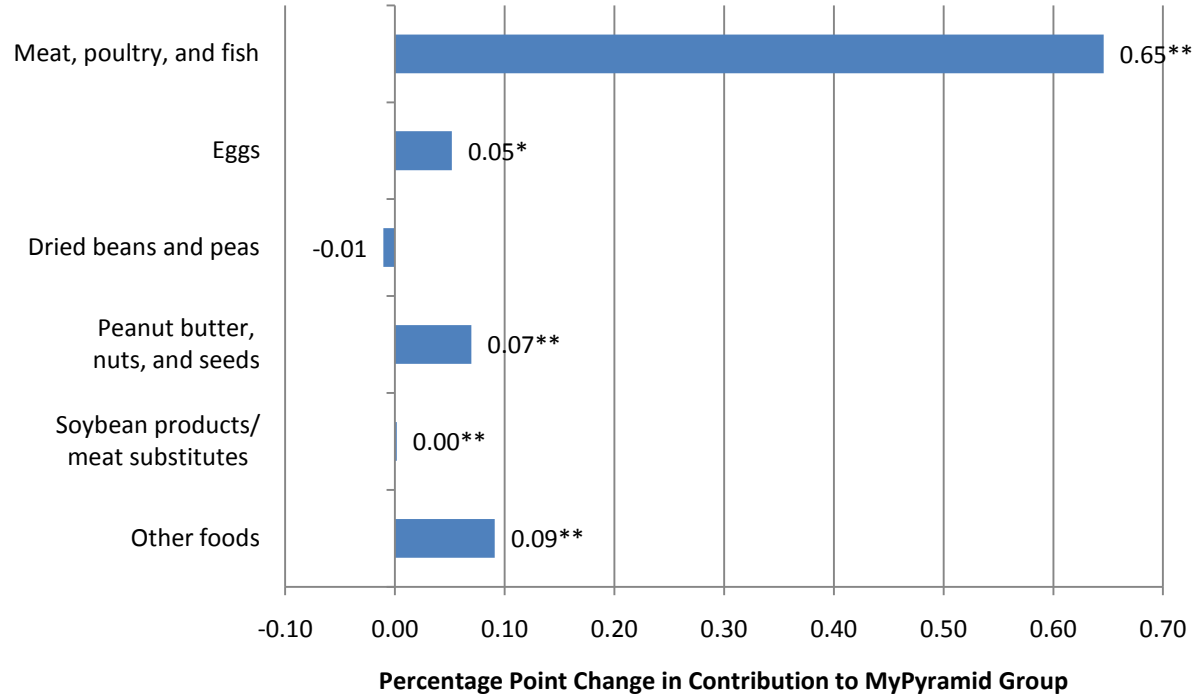


Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure VII.14 Percentage Point Change in Intake of Foods that Contribute to MyPyramid Meat and Beans Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals



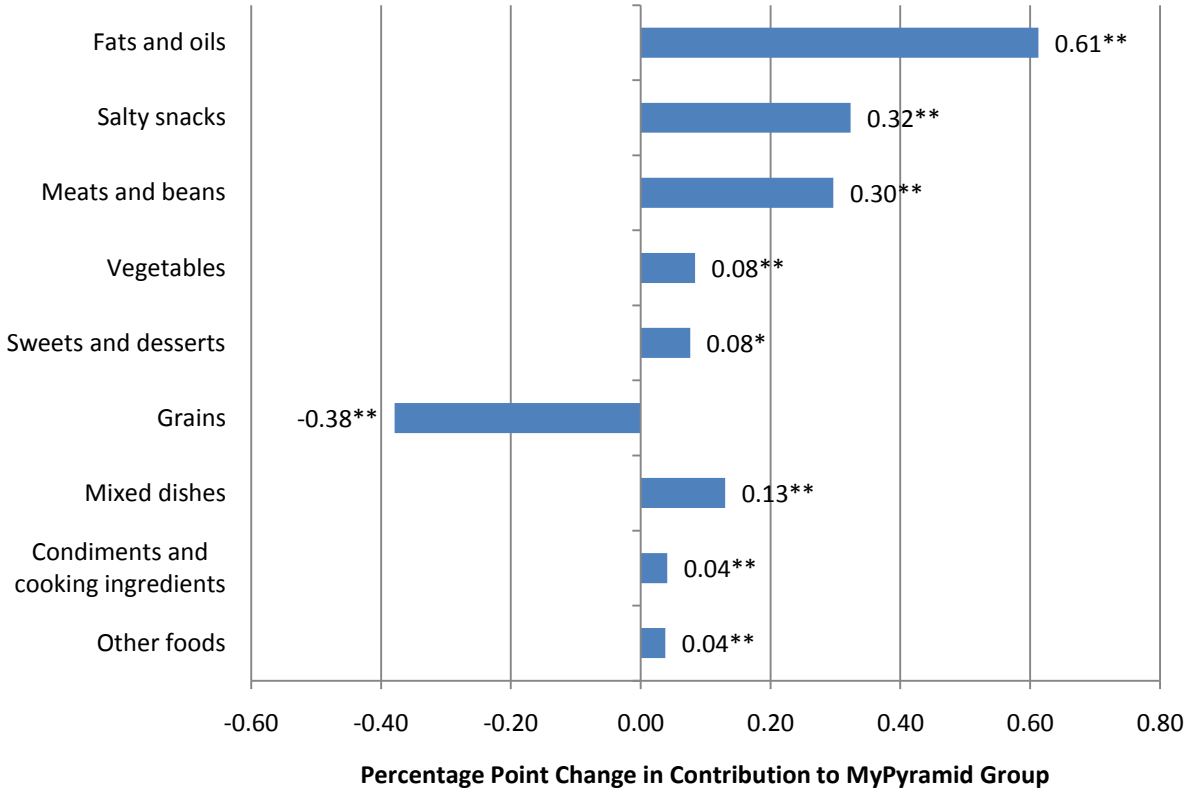
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Low-income individuals with higher diet cost consume smaller shares of discretionary fats and oils from grains and larger shares from fats and oils, salty snacks, meats and beans, vegetables, sweets and desserts, mixed dishes, condiments and cooking ingredients, and other foods than those individuals with lower diet cost (Figure VII.15). Similar findings exist for the shares of individuals' intakes of Saturated Fats from specific types of foods (Figure VII.16).

Figure VII.15 Percentage Point Change in Intake of Foods that Contribute to Discretionary Solid Fat and Oils Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals

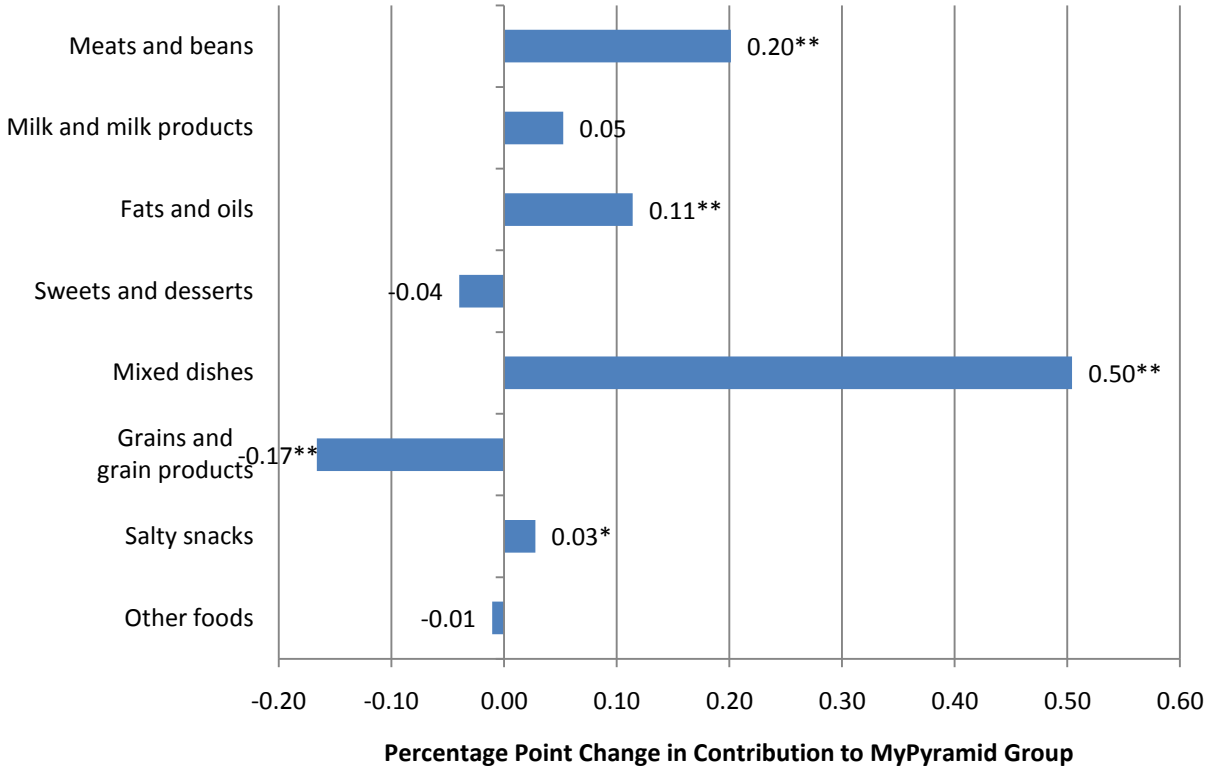


Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure VII.16 Percentage Point Change in Intake of Foods that Contribute to Saturated Fats Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals



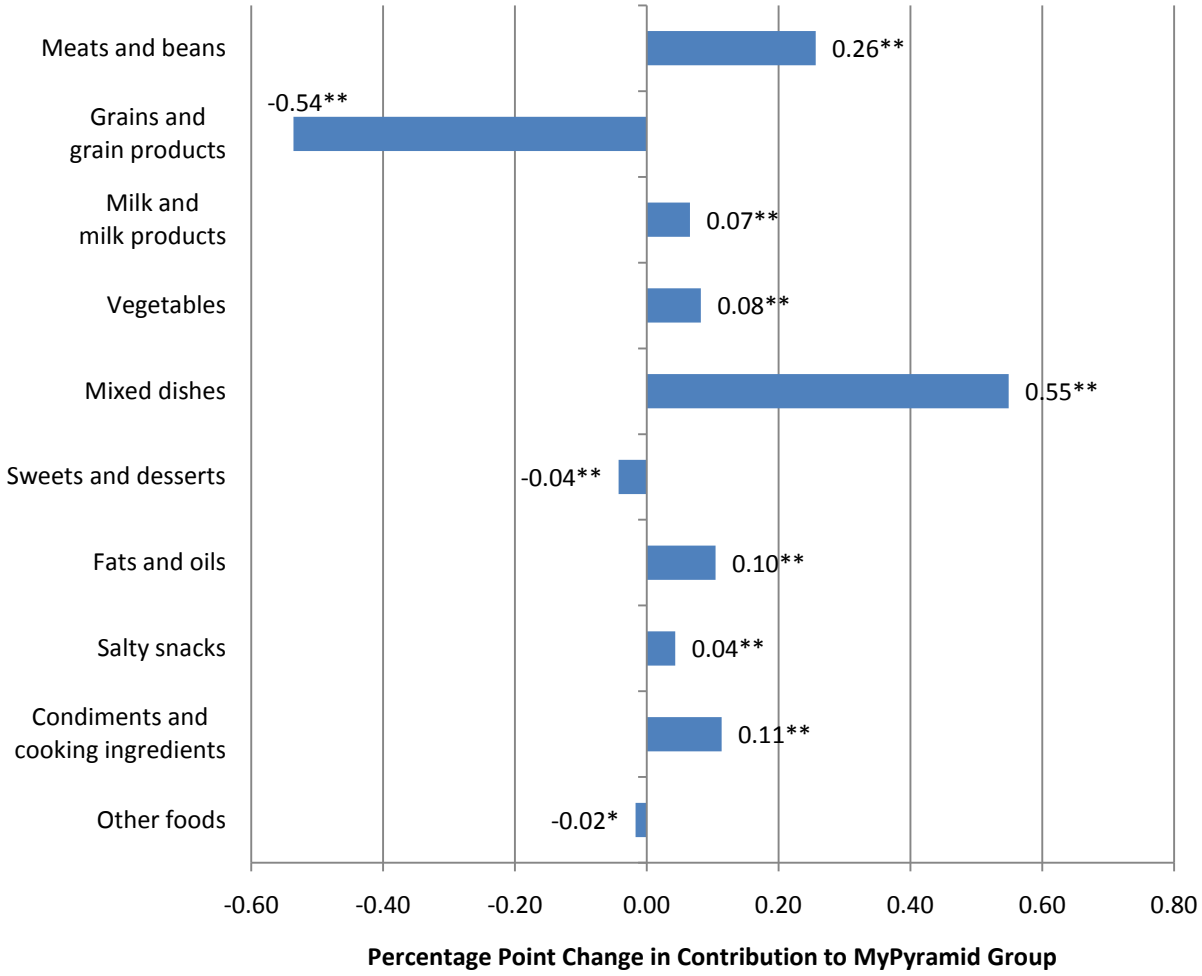
Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Low-income individuals with higher diet cost consume larger shares of sodium from meats and beans, milk and milk products, vegetables, mixed dishes, fats and oils, salty snacks, and condiments and cooking ingredients, and smaller shares of sodium from grains and grain products, sweets and desserts, and other foods, relative to lower diet cost individuals (Figure VII.17). Low-income individuals also consume smaller shares of calories from SOFAAS from grains and grain products and sweets and desserts, relative to lower diet cost individuals (Figure VII.18).

Figure VII.17 Percentage Point Change in Intake of Foods that Contribute to Sodium Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals

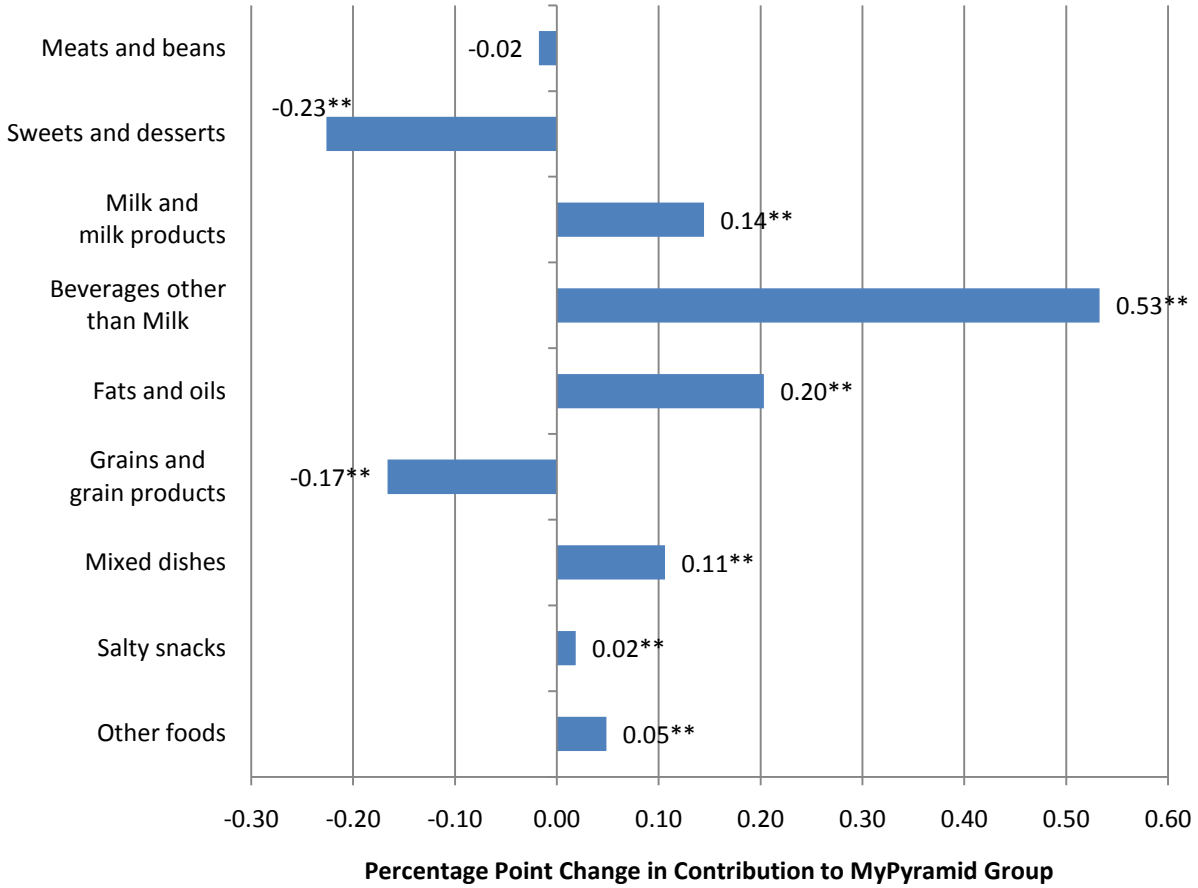


Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure VII.18 Percentage Point Change in Intake of Foods that Contribute to Calories from SOFAAS Associated With a 10 Percent Increase in Diet Cost for Low-Income Individuals



Source: 2001–2004 NHANES appended with price data

Universe: Individuals with income under 300 percent of poverty.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

4. Estimates of the Association Between Diet Cost and the Relative Contribution of Specific Foods to MyPyramid Groups, Saturated Fat, Sodium, and Calories from SoFAAS for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

In this section, we present the NHANES results for the same regression estimated using subgroups defined by SNAP participation and eligibility group. We present only selected results showing whether the associations between diet cost and the relative contribution of specific foods to MyPyramid groups, saturated fat, sodium, and calories from SOFAAS exist for each SNAP participation and eligibility group. The full set of results are available from the authors.

The results indicate that:

- SNAP participants, eligible nonparticipants and ineligible nonparticipants with higher diet costs consume larger shares of total fruit from whole fruit. However, only SNAP

ineligible nonparticipants with higher diet costs consume larger shares of total fruit from 100 percent fruit juice than those with lower diet costs.

- SNAP eligible and ineligible nonparticipants with higher diet costs consume smaller shares of total milk from fluid milk. However, only SNAP participants with higher diet costs consume larger shares of total milk from whole milk and smaller shares from skim milk than those with lower diet costs. In fact, eligible nonparticipants with higher diet costs consume smaller shares of total milk from whole milk.
- SNAP eligible and ineligible nonparticipants with higher diet costs consume smaller shares of total grains from grains and grain products. Additionally, only SNAP eligible nonparticipants with higher diet costs consume smaller shares of total grains from non-whole grains than those with lower diet costs. The association with whole grains is not significant for any SNAP participation and eligibility group.
- SNAP participants with higher diet costs consume larger shares of meats and beans from eggs than those with lower diet costs. This result is not present for eligible and ineligible nonparticipants. In addition, only SNAP eligible nonparticipants with higher diet costs consume larger shares of meats and beans from dried beans and peas than those with lower diet costs.
- Similar findings exist across SNAP participation and eligibility groups for the relationships between diet cost and the shares of discretionary fats and oils, saturated fats, sodium, and calories from SOFAAS from specific types of foods. One exception is the share of saturated fats from consumption of milk and milk products. SNAP participants with higher diet cost consume larger shares of saturated fats from milk and milk products than those with lower diet costs. This result is not present for eligible and ineligible nonparticipants.

VIII. SHARE OF FOOD EXPENDITURES SPENT ON FOOD CATEGORIES

For our final outcome measure, we examine the relationship between food expenditures and the expenditure shares on food categories. The previous chapter identified the food choices of SNAP households (using NFSPS data) and low-income individuals (using NHANES data). In this chapter we use CE-Diary data to examine the share of expenditures that consumers devote to different types of foods. Using these data provides another opportunity to examine differences across participation and eligibility groups. As the 2005 data were available at the start of the study, they are more recent than the other data sets.

Using the CE-Diary, we calculate expenditure shares by forming ratios between (1) the amount spent on a particular broad food group, such as foods recommended for frequent consumption, or on a specific food group, such as fresh fruit, and (2) total food expenditures. All expenditures are based on a seven-day recall period. We then estimate the associations between total food expenditures and food expenditure shares in a regression framework. Similar to the NHANES analysis, eligible nonparticipants are defined as nonparticipating consumer units whose income is at or under 130 percent of poverty, and ineligible nonparticipants are nonparticipating units whose income is between 130 percent and 300 percent of poverty.

We separated the foods identified in the CE-Diary data into three groups:

- **Foods recommended for frequent consumption:** Fresh fruit, other fruit, fresh vegetables (including potatoes), other vegetables, dried beans and peas
- **Foods not recommended for frequent consumption:** Sweetened beverages, baked desserts, other sweets, salty snacks, high-fat/sodium meats, high fat dairy, fats and oils, alcohol, juices
- **Other foods:** Grains and grain products, meats and meat alternatives, other dairy products, eggs, nuts and seeds, coffee and tea, mixed dishes, condiments and seasoning, miscellaneous

We use the "other" category to capture foods for which we do not have enough information to be able to categorize them as recommended for frequent consumption or not.[52]

By examining how low-income consumer units[53] allocate their spending across food categories and how they increase their spending given a 10 percent increase in total food purchases, we find:

[52] A more complete description of the foods in each category can be found in Appendix H.

[53] Consumer units are defined as members of a household consisting of (a) occupants related by blood, marriage, adoption, or some other legal arrangement; (b) a single person living alone or sharing a household with others, but who is financially independent; or (c) two or more persons living together who share responsibility for at least two out of three major types of expenses—food, housing, and other expenses. Students living in university-sponsored housing also are included in the sample as separate consumer units.

- About one-third of food expenditures are on foods not recommended for frequent consumption; close to half are on foods that cannot be categorized given the information available in the CE-Diary data.
- Low-income consumer units who spend relatively more on food purchase slightly greater shares of each type of food identifiable as recommended for frequent consumption, but they also purchase a slightly larger percentage of most foods not recommended for frequent consumption (the exception is sweetened beverages) and foods that are not identifiable (the exception is many dairy products).
- The patterns for all low-income consumer units generally hold regardless of participation in and eligibility for SNAP.

A. Allocation of Food Expenditures across Food Categories for Low-Income Consumer Units

Low-income consumer units spend 16.4 percent of their total food expenditures on foods that can be identified in the CE-Diary data as recommended for frequent consumption (Table VIII.1). Slightly over one-third of expenses are on foods not recommended for frequent consumption. However, it is important to note this does not necessarily mean that the remaining foods were not healthy. Indeed, there are many foods in the "other" category that consumer units purchase in a larger share relative to both the recommended and not recommended foods (47.6 percent). If we had sufficient information to be able to group these foods as either recommended for frequent consumption or not, it is possible we would find that low-expenditure consumer units purchase a greater share of foods recommended for frequent consumption, as compared to high-expenditure units.

Within the category of foods recommended for frequent consumption, low-income consumer units spend the most on fresh fruit and fresh vegetables (5.2 percent and 4.7 percent of total food expenditures, respectively). They spend a slightly smaller share on other vegetables, such as frozen vegetables and prepared salads.

Among foods not recommended for frequent consumption, low-income consumer units spend greater shares of total expenditures on sweetened beverages (8.7 percent), high-fat dairy products such as cream, cheese, and ice cream and frozen yogurt (5.2 percent), and alcohol (4.5 percent). The smallest shares are spent on juices (2.6 percent).

Finally, among "other" foods, low-income consumer units spend 14.2 percent of total food expenditures on meats and meat alternates and 10.2 percent on grains and grain products. They spend a smaller amount on mixed dishes such as soup, frozen meals, and prepared food other than meals (4.6 percent) and eggs (1.3 percent). For these foods, not enough information is available to determine their consistency with recommended eating guidelines.

Table VIII.1 Shares of Total Food Expenditures Spent across Food Categories

Foods Recommended for Frequent Consumption	13.85
Fresh fruit	5.16
Other fruit	0.77
Fresh vegetables	4.69
Other vegetables	3.10
Dried beans and peas	0.13
Foods Not Recommended for Frequent Consumption	**38.51**
Sweetened beverages	8.69
Baked desserts	3.97
Other sweets	4.10
Salty snacks	2.78
High-fat or high-sodium meats	4.09
High-fat dairy[a]	5.17
Fats and oils	2.72
Alcohol	4.46
Juices	2.55
Other Foods	47.64
Grains and grain products	10.16
Meats and meat alternates	14.22
Dairy products[a]	7.50
Eggs	1.31
Nuts and seeds	0.97
Coffee and tea	2.22
Mixed dishes	4.63
Condiments and seasoning	2.53
Miscellaneous	4.09
Total	100.00

Source: 2005 CE-Diary data

Universe: Consumer units with income under 300 percent of poverty

Note: See Appendix H for a table showing the expenditure shares by income groups.

[a] High-fat dairy products include cream, cheese, ice cream, and frozen yogurt. Other dairy products include powdered milk and fresh, canned, and non-frozen yogurt.

B. The Relationship Between the Allocation of Food Expenditures Across Food Categories and Total Food Expenditures

We now examine how the expenditure shares are associated with total food expenditures while accounting for differences across consumer units in a broad set of demographic and economic characteristics. Unlike we did for the earlier outcome measures, here we focus on the absolute change in the expenditure share (in percentage points), rather than a percentage change in the expenditure share, from a 10 percent increase in total food expenditures.

1. Methodological Approach

The empirical framework is largely the same as in the NFSPS and NHANES analysis. We estimate regressions in which the expenditure shares are the dependent variable and the natural

logarithm of total food expenditures is the main independent variable. The main methodological difference between that approach and the one used in this chapter is that we estimate a Tobit regression model rather than a standard OLS regression model. This is because, when using expenditure shares as the dependent variable, non-trivial proportions of consumer units in the sample that do not have positive expenditures for a specific food group may lead to biased estimates using an OLS model (Tobin 1958). The Tobit model accommodates these types of observations in the sample by separating the decision to purchase a type of food, such as fresh fruit, from the decision about how much of the type of food to purchase, given that the unit has decided to buy a positive amount. For foods or beverages for which most households do not purchase very much relative to their total food expenditures, such as expenditures on juice, an OLS regression model relating food expenditures to the expenditure share for juice would produce a biased estimate of this association because only a few households purchase a positive amount. The Tobit model addresses this bias by emphasizing the decision to purchase the good, rather than how much to purchase, when the good is purchased by few households in the sample. As the number of households that purchase the good increases, the Tobit estimates of the association between food expenditures and the expenditure shares converge to the OLS estimates.

Unlike the empirical models used for most of the NFSPS analyses and all of the NHANES analyses, regression coefficients of the Tobit model here have relatively little intuitive meaning. Therefore, we do not report them in the summary figures and tables in this chapter. Rather, we use the regression coefficients to compute "marginal effects," or the change in the expenditure share (in percentage points) such as fresh fruit expenditures, resulting from a one percent increase in total food expenditures. As in prior chapters, we multiply these values by 10 so that they represent the change in the expenditure share associated with a 10 percent increase in food expenditures, which is approximately $6.43 for the mean consumer unit in the sample (mean food expenditures are $64.31). For example, an estimate of 0.50 indicates that a $6.43 increase in food expenditures is associated with an increase of 0.50 percentage points (less than one percentage point) in the expenditure share.

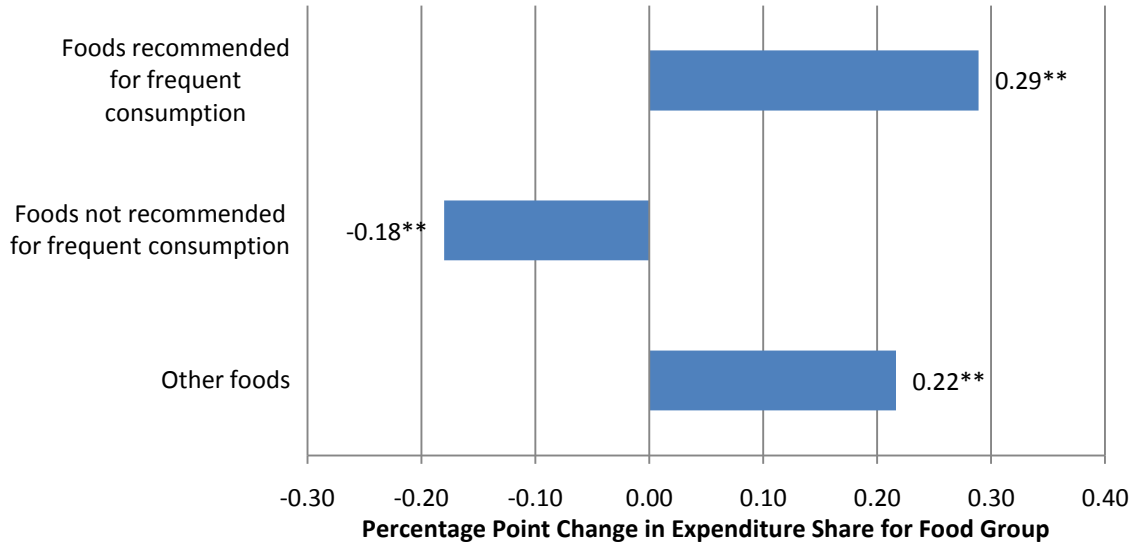
The set of explanatory variables in the regression model differs from those in the NFSPS and NHANES analysis, in part because the unit of observation is the consumer unit rather than the household or individual, and because the CE-Diary data contain different information. The variables used include SNAP participation and eligibility status; household composition; the head of the unit's marital status, gender, race and ethnicity; and age. Additional demographic characteristics include geographic location and population density of the primary sampling unit in which the consumer unit lives, the number of children younger than 18 years old in the unit, and the season of the year in which the consumer unit participated in the survey.

2. Estimates of the Association Between Food Expenditures and Expenditure Shares for Low-Income Consumer Units

A 10 percent increase in spending on food is associated with an increase of 0.29 percentage points in the share of spending on foods recommended for frequent consumption (increasing from 13.85 percent to 14.14 percent). The same increase in spending is also associated with an increase of 0.22 percentage points in the share of spending on other foods, and a 0.18 percentage point decrease

in spending on foods not recommended for frequent consumption (Figure VIII.1).[54] We do not have a strong basis for determining whether the magnitude of these changes are small or large on a conceptual basis, though relative to the variation of the share of food expenditures spent on each category in the sample, they appear to be small.

Figure VIII.1 Percentage Point Change in Share of Total Expenditures Associated with a 10 Percent Increase in Food Expenditures for Foods Recommended for Frequent Consumption, Foods Not Recommended for Frequent Consumption, and Other Foods



Source: 2005 CE–Diary data

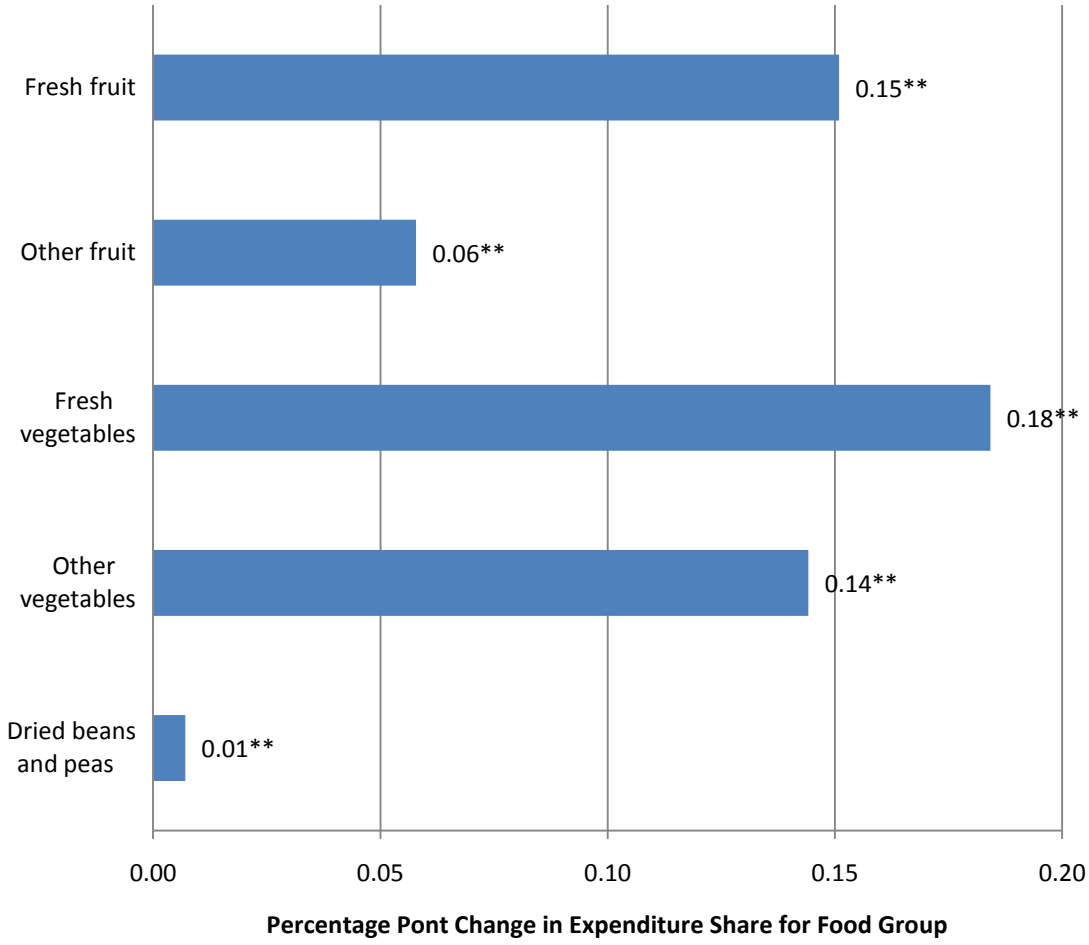
Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty

[54] We estimate all regressions in this chapter separately (rather than jointly as a system of equations) because of the computational burden associated with estimating such a large number of equations. As a result, we do not impose an "adding up" condition in which the changes in the share of each food spending category from a 10 percent increase in food expenditures sum to 1.

For foods recommended for frequent consumption, low-income consumer units who spend more on food purchase greater shares of fresh fruit and fresh vegetables than those who spend less on food (Figure VIII.2). They also purchase greater shares of other fruit and vegetables and dried beans and peas.

Figure VIII.2 Percentage Point Change in Expenditure Share Spent on Specific Foods Recommended for Frequent Consumption that are Associated with a 10 Percent Increase in Food Expenditures



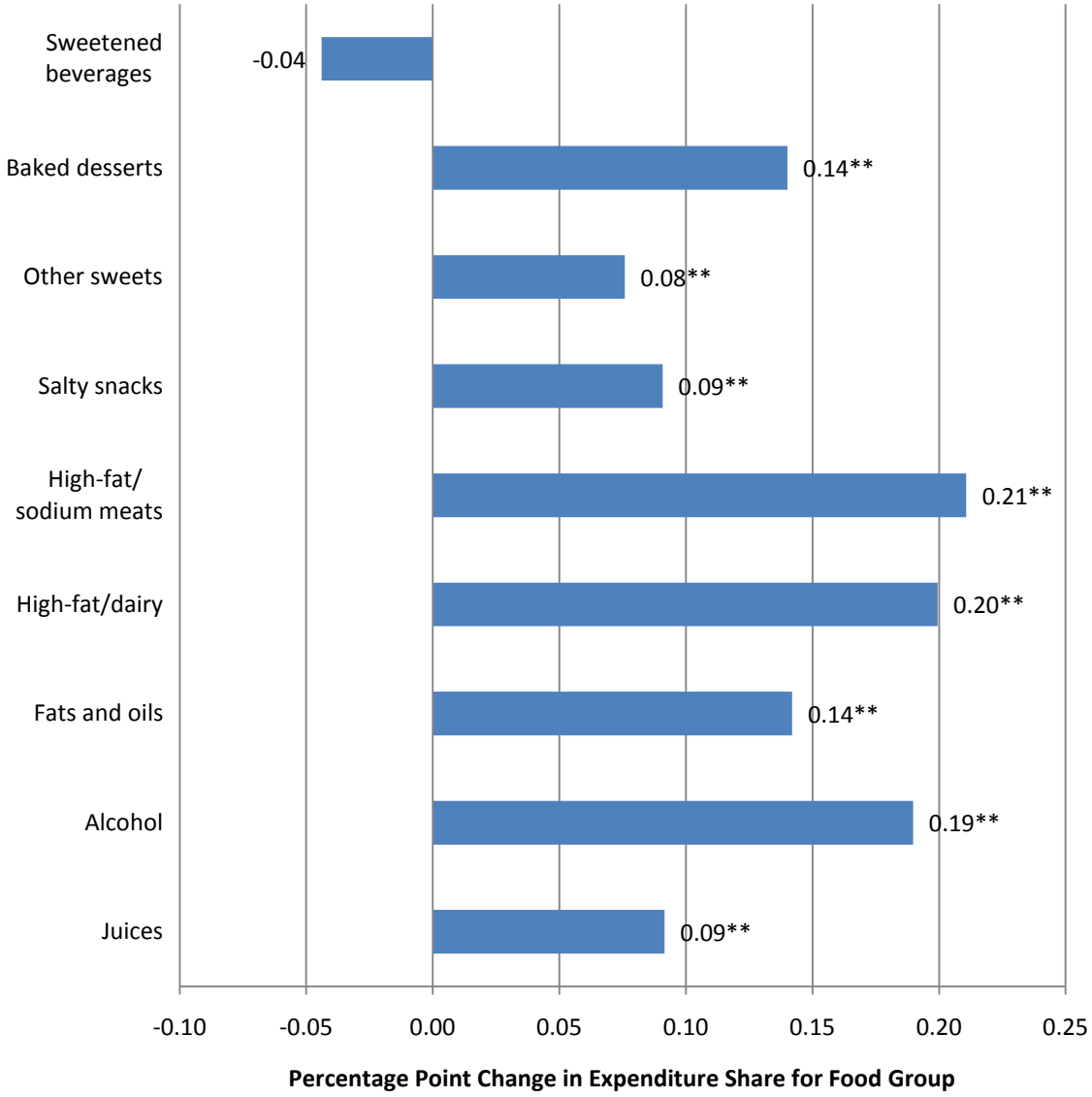
Source: 2005 CE–Diary data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty

Low-income consumer units who spend more on food also purchase greater shares of baked desserts; other sweets; salty snacks; high-fat or high-sodium meats; high-fat dairy products such as cream, cheese, and frozen yogurt; fats and oils; alcohol; and juices than those who spend less on food (Figure VIII.3).

Figure VIII.3 Percentage Point Change in Expenditure Share Spent on Specific Foods Not Recommended for Frequent Consumption that are Associated with a 10 Percent Increase in Food Expenditures



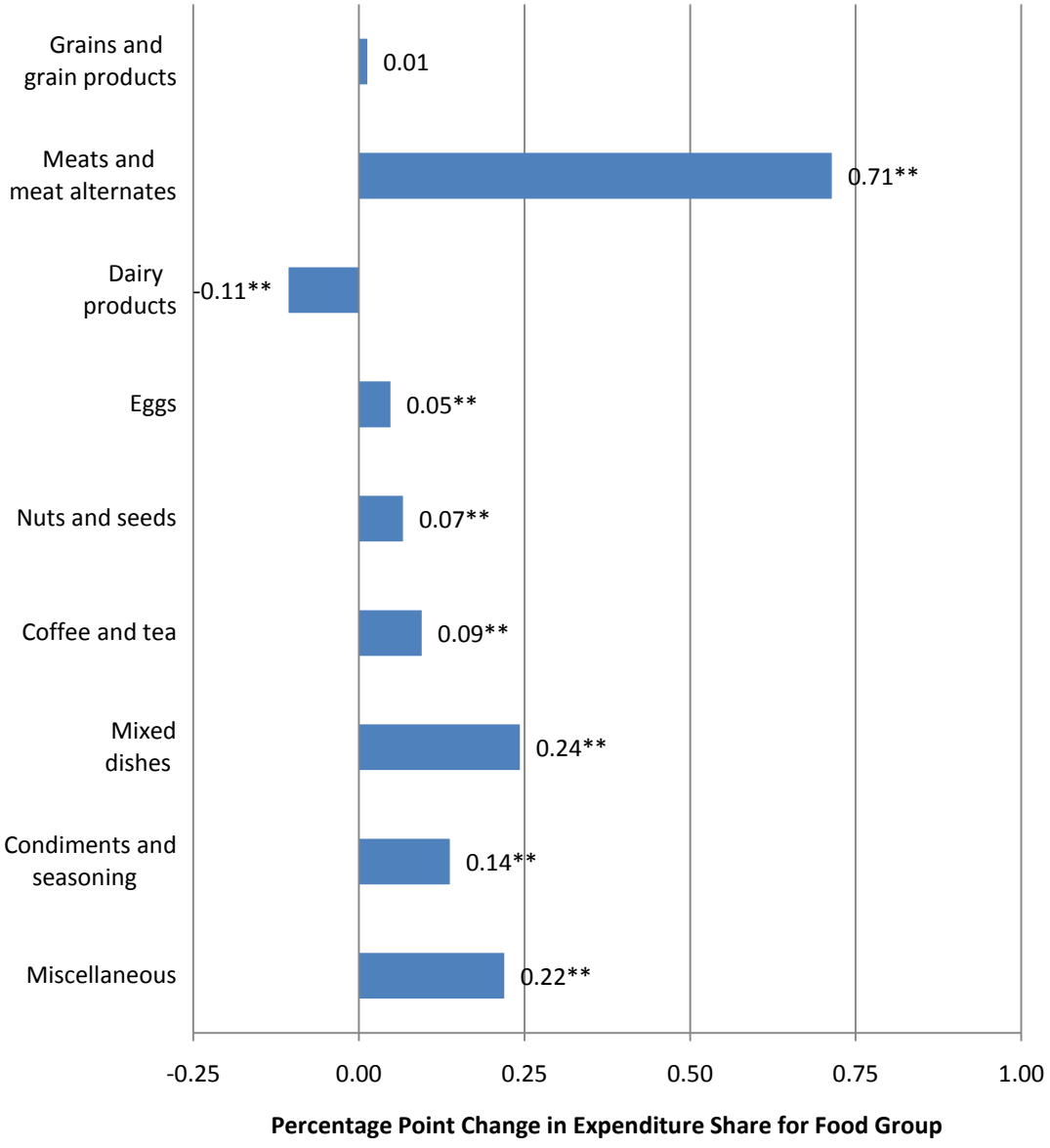
Source: 2005 CE–Diary data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty

Finally, low-income consumer units who spend more on food purchase smaller shares of dairy products (including powdered milk and fresh, canned, and non-frozen yogurt) and greater shares of eggs, nuts and seeds, coffee and tea, meats and meat alternates, condiments and seasonings, and miscellaneous foods than those who spend less on foods (Figure VIII.4). The limited description in the data set prevents these foods from being classified as either recommended or not recommended for frequent consumption.

Figure VIII.4 Percentage Point Change in Share of Total Expenditures Spent on Other Foods that are Associated with a 10 Percent Increase in Food Expenditures



Source: 2005 CE–Diary data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

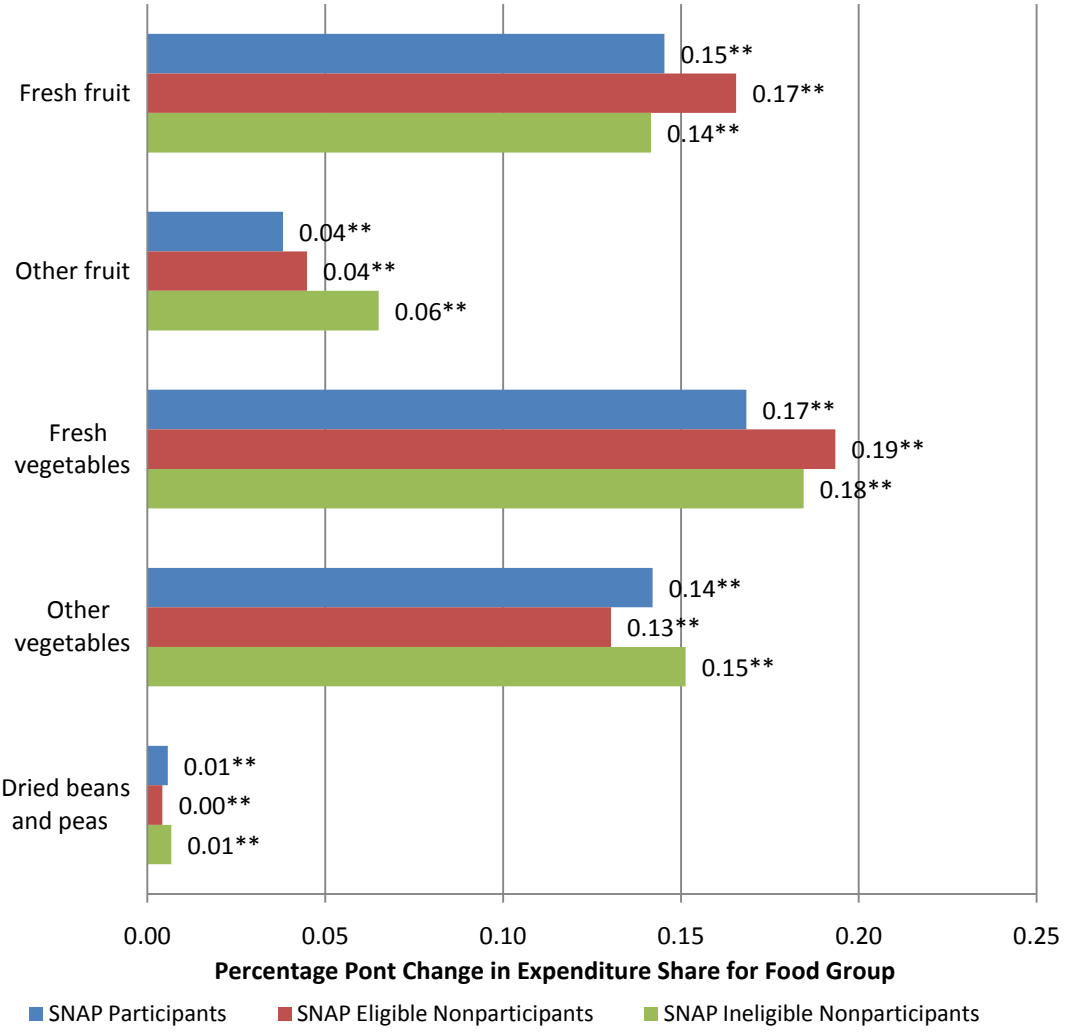
Universe: Consumer units with income under 300 percent of poverty

3. Estimates of the Association Between Food Expenditures and Expenditure Shares for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants

In this section we present the results for the same Tobit regressions estimated using subgroups defined by SNAP participation and eligibility group. Each figure shows whether the associations between expenditure shares and total food expenditures exist for each subgroup.

Low-income consumer units in all three SNAP subgroups who spend more on food spend more on fresh fruit and vegetables than those who spend less on food (Figure VIII.5). They also spend more on other fruit and vegetables. Finally, for ineligible nonparticipants who spend more on food, we see a statistically significantly increase in the share of expenditures dedicated to dried beans and peas.

Figure VIII.5 Percentage Point Change in Expenditure Share Spent on Specific Foods Recommended for Frequent Consumption that are Associated with a 10 Percent Increase in Food Expenditures, for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants



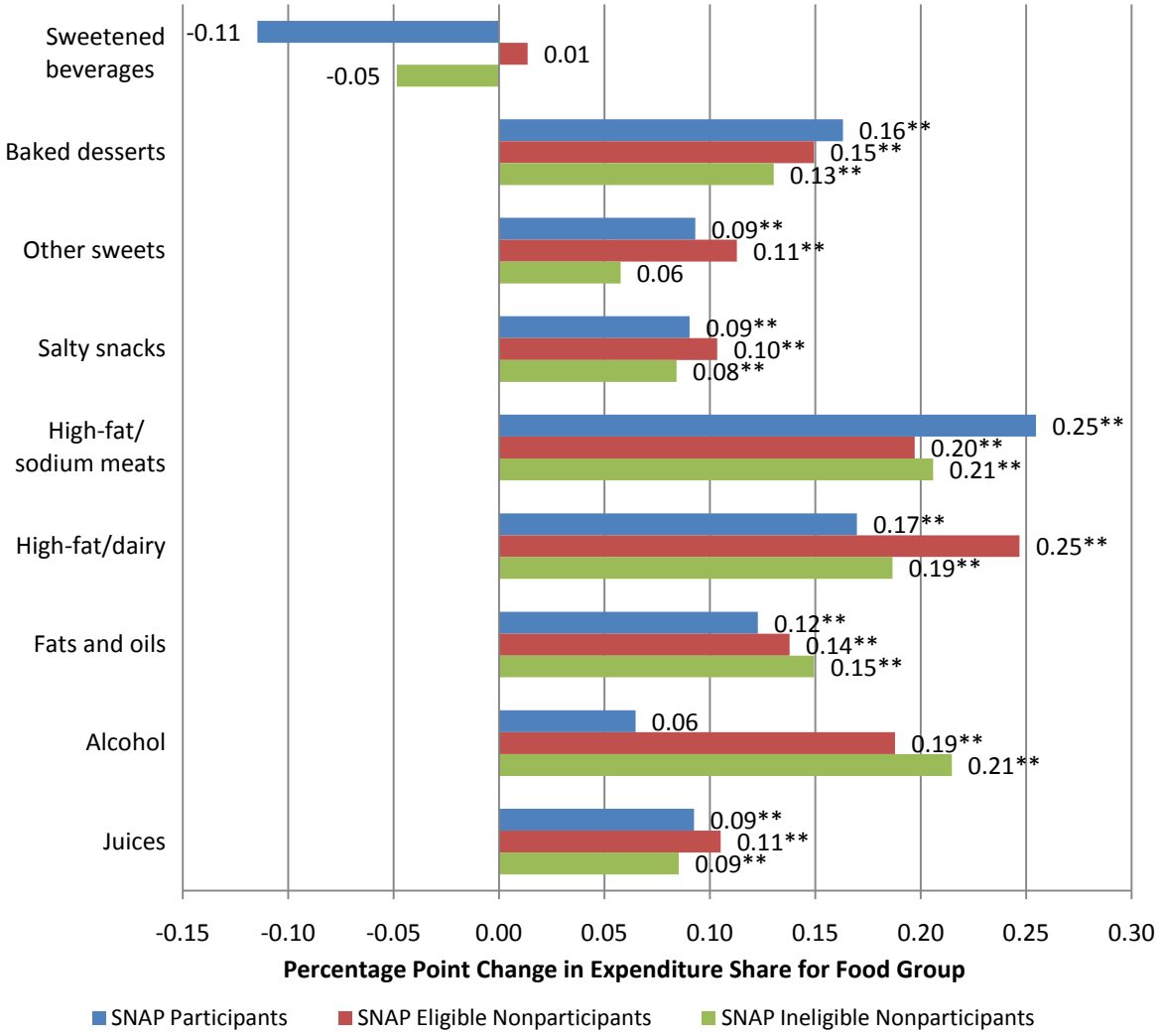
Source: 2005 CE–Diary data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty.

For foods not recommended for frequent consumption, SNAP participants who spend more on food purchase greater shares of most of these categories of foods than those who spend less on food (Figure VIII.6). The exception is sweetened beverages: in Table VIII.1 we see that they account for about one-fourth of expenditures on foods not recommended for frequent consumption. Spending more on food does not statistically change the share of expenditures spent on sweetened beverages across any of the eligibility and participation groups.

Figure VIII.6 Percentage Point Change in Expenditure Share Spent on Specific Foods Not Recommended for Frequent Consumption that are Associated with a 10 Percent Increase in Food Expenditures, for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants



Source: 2005 CE–Diary data

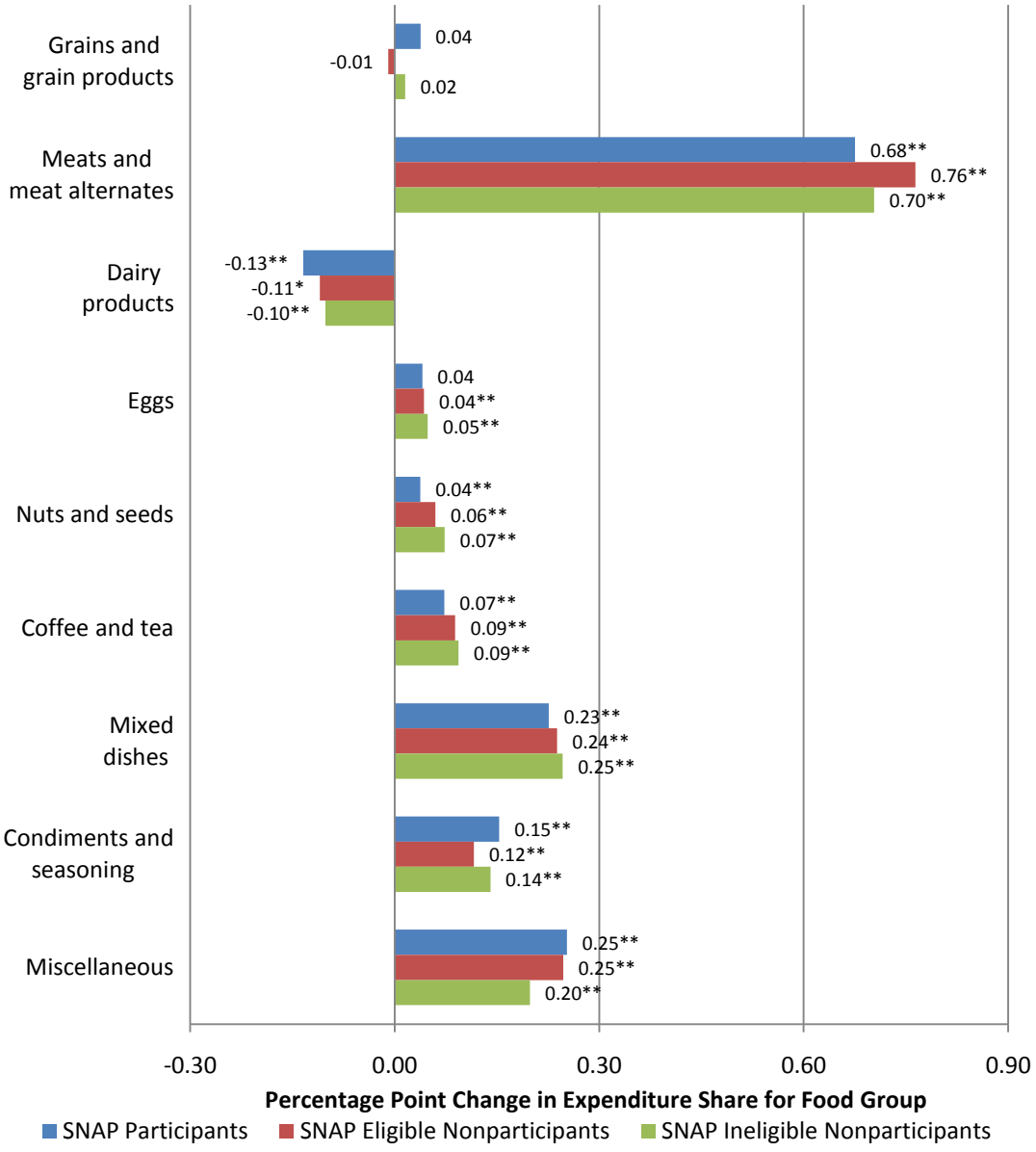
Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty

Figure VIII.7 presents the change for foods in the "other" group that cannot be categorized as either recommended or not recommended. Consumer units in all three participation and eligibility groups purchase a smaller share of dairy products, such as fresh milk (of all types) and fresh, canned,

and non-frozen yogurt, although we can see from Figure VIII.6 that they purchase more dairy foods that are identifiable as high in fat. Also for other foods that cannot be categorized as recommended or not recommended for frequent consumption, units in all three groups who spend more on food purchase greater shares of meat and meat alternates such as pork chops, canned ham, and fresh and frozen chicken.

Figure VIII.7 Percentage Point Change in Expenditure Share Spent on Specific Other Foods that are Associated with a 10 Percent Increase in Food Expenditures, for SNAP Participants, Eligible Nonparticipants, and Ineligible Nonparticipants



Source: 2005 CE–Diary data

Note: * or ** denote estimate is statistically significant at the 0.05 or 0.01 level, respectively.

Universe: Consumer units with income under 300 percent of poverty

This page has been intentionally left blank for double-sided copying.

IX. CONCLUSIONS

The findings from the study indicate that higher expenditures on food are associated with higher diet quality, particularly for the overall summary measures. The increases, though statistically significant, tend to be small relative to the variation in the values of the diet quality measure in the sample. Almost all increases associated with a 10 percent increase in food spending are less than 3 percent, and many are under 1 percent.

A. Relationships Between Food Expenditures and Diet Quality

As presented in Figure IX.1, the sign of the association of each of the measures is in the direction of improved diet quality. That is, the HEI-2005 and nutrient density scores increase with expenditures, the energy density measure decreases, SNAP participants and low-income individuals spend a larger share of their food expenditures on foods recommended for frequent consumption, and low-income individuals spend a smaller share on foods not recommended for frequent consumption.

1. HEI-2005

A 10 percent increase in food expenditures (an increase of $5.91 per week based on mean expenditures) among SNAP participants, as examined through the NFSPS, is associated with an increase in the HEI-2005 score of 0.33 percent, or from 52.31 to 52.48 (Figure IX.1). For the low-income population, using NHANES, a 10 percent increase in diet cost (an increase of $0.43 per day based on mean expenditures) is associated with an increase in the HEI-2005 score of 0.30 percent, or from 56.60 to 56.77. Although several of the results from both data sources are positive and statistically significant, the magnitudes of the changes are small relative to the variation in HEI-2005 scores in the sample.

The findings from both data sets indicate that the largest percentage increase in the component scores is for whole fruit. Scores for total fruit, total vegetables, and oils are also significantly higher for those spending more on food. For low-income individuals with higher diet costs, scores are lower for total grains, whole grains, saturated fat, and calories from solid fats, alcohol, and added sugars (SoFAAS) than for individuals with lower diet costs.

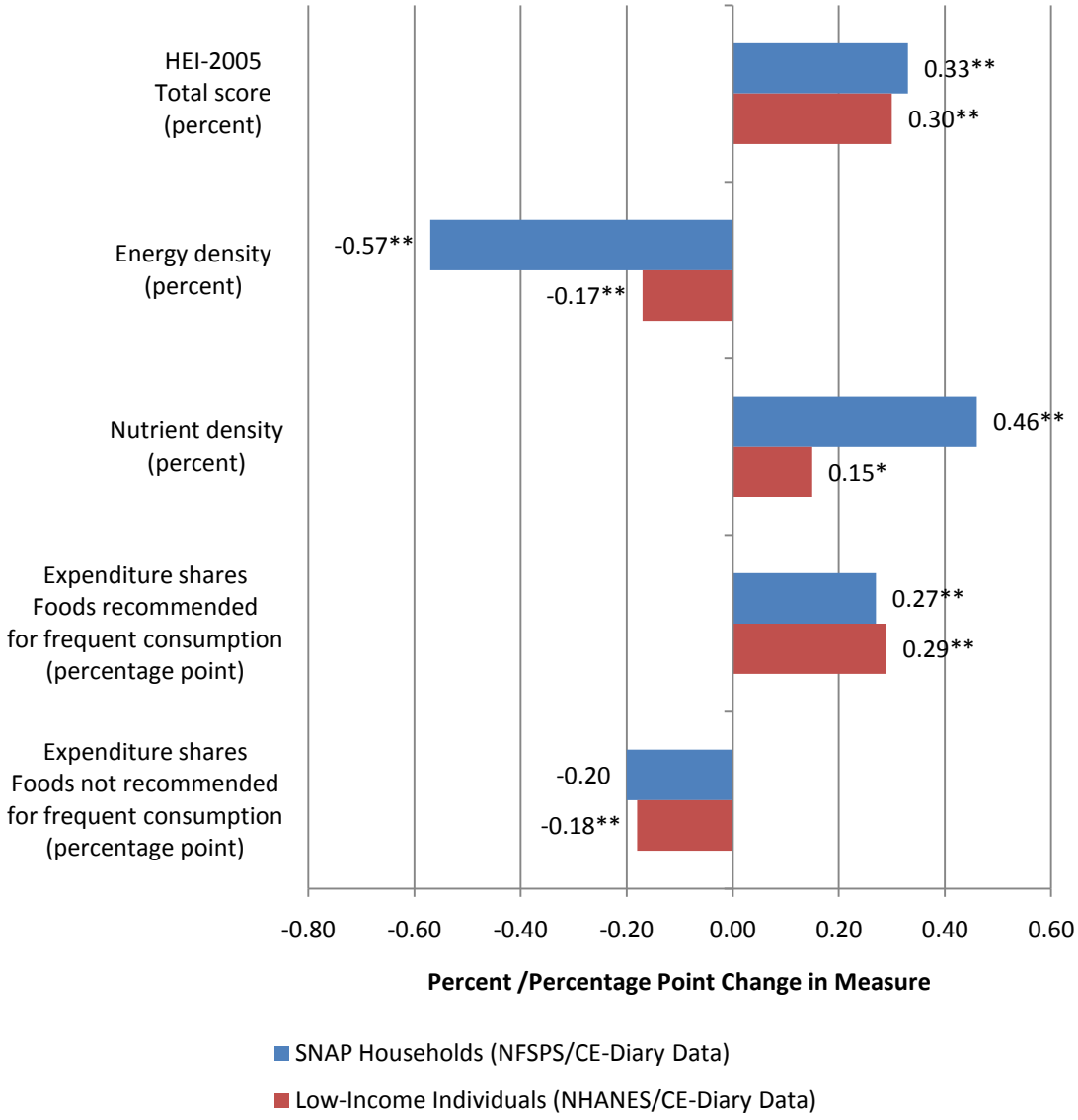
2. Nutrient Availability/Intake

Among SNAP participants examined through the NFSPS and low-income individuals examined through the NHANES, greater diet costs are associated with higher availability or intake of vitamins A, B_6, B_{12}, C, and E per 1,000 calories. Also for SNAP participants in NFSPS, greater spending on food is associated with higher availability of calcium, folate, iron, and potassium. From the NHANES, low-income individuals with higher diet costs consume greater amounts of niacin, magnesium, and potassium per 1,000 calories than do low-income individuals with lower diet costs. However, they also consume higher amounts of sodium and lower amounts of folate, riboflavin, thiamin, and iron per 1,000 calories.

As with the HEI-2005 changes, the magnitudes are small relative to the variation in nutrient availability across households and individuals in the samples. The largest percentage increase is for

Vitamin C, at 2.71 percent for SNAP participants and 2.87 for low-income individuals. Most of the other differences are less than 1 percent.

Figure IX.1 Percentage/Percentage Point Change in Summary Measures Associated with 10 Percent Increase in Food Expenditures



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

3. Energy Density

Energy density is the available food energy per unit weight, that is, calories per gram. Foods with high water content, such as fruits, vegetables, and milk, have low energy density, as do whole grains and cereals. Based on the NFSPS data, SNAP participants who spend more on food use

foods from their home food supply that are slightly lower in energy density. That is, a 10 percent increase in spending on food is associated with a decrease in energy density of 0.57 percent. Among low-income individuals, as measured through NHANES, those with greater diet costs consume foods that are 0.17 percent lower in energy density.

4. Nutrient Density

SNAP participants, measured through the NFSPS, who spend 10 percent more on food score 0.46 percent higher on the nutrient-rich score. Low-income individuals with higher diet costs, measured through NHANES, scored 0.15 percent higher. For SNAP participants, most of the increase results from higher component scores from grains and grain products, and from sweets, desserts, and salty snacks. For low-income individuals, the increase is driven largely by the component scores on fruit, vegetables, and sweets, desserts, and salty snacks.

5. Expenditure Shares

Low-income individuals spend 13.85 percent of their food expenditures on foods that can be identified in the CE-Diary data as recommended for frequent consumption. They spend about 38.51 percent on foods not recommended for frequent consumption, and almost half on foods that cannot be identified with information available in the data as to whether or not they are recommended for frequent consumption. Higher expenditures on food are associated with an increase of 0.29 percentage points (to 14.14 percent) on foods recommended for frequent consumption, and a decrease of -0.18 percentage points (to 38.33 percent) on foods not recommended for frequent consumption.

B. Results by Food Categories

Most of the measures, with the exception of nutrient availability, can be examined separately by food categories.

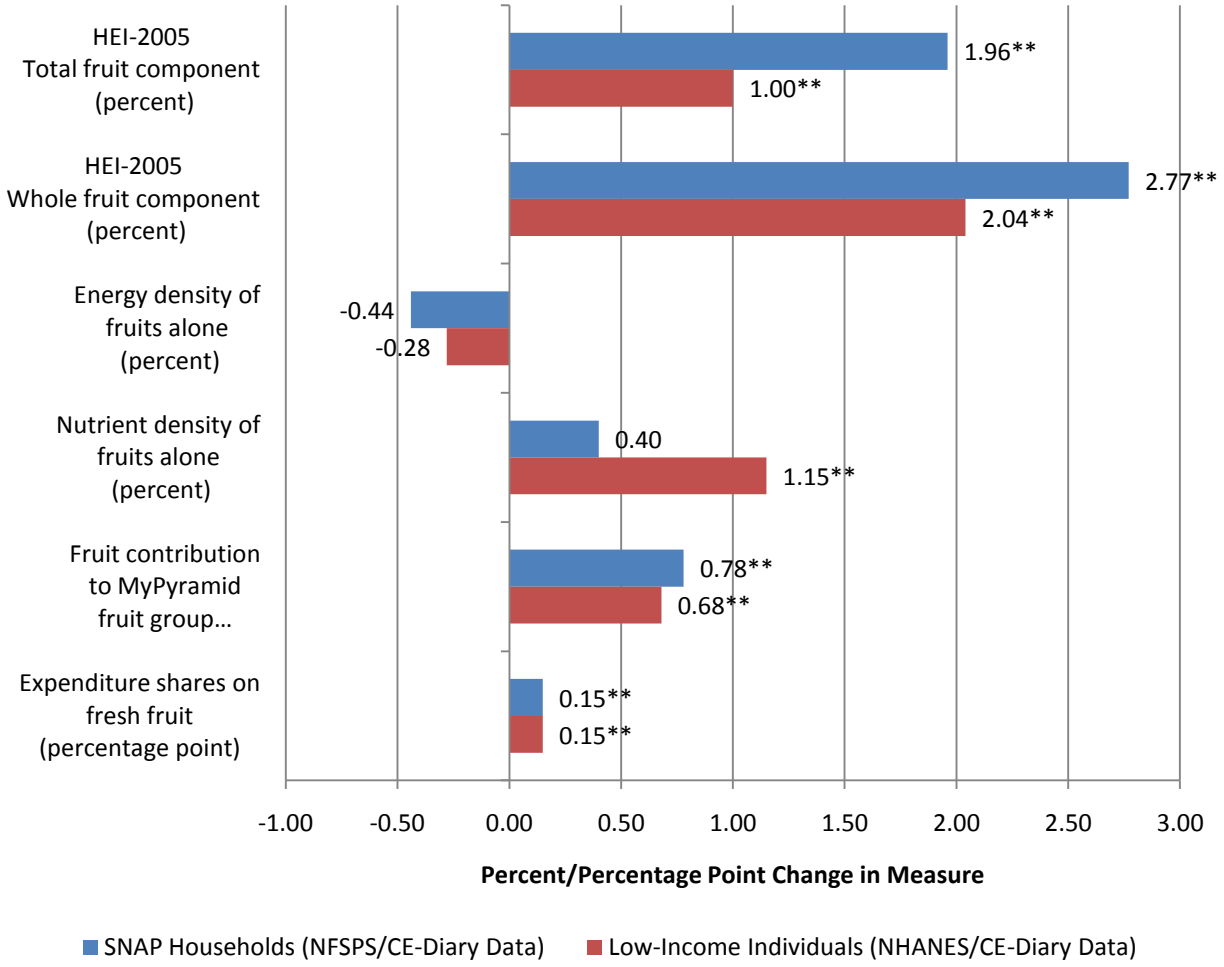
1. Fruit

With the nutrition measures discussed above, higher food expenditures are associated with higher use and intake of fruits (Figure IX.2). For example, a 10 percent increase in food spending by SNAP participants is associated with a 1.96 percent increase in the HEI-2005 total fruit component score, increasing the fruit component of the HEI-2005 from 2.70 to 2.75 (out of a maximum of 5). The increase is even larger for whole fruits (excluding fruit juices), which have been one of the focal points for recent policy and public health discussions. A 10 percent increase in food expenditures is also associated with intake of fruits by low-income individuals that were 1.15 percent higher in nutrient density.

The food shares measure indicates the relative contribution of specific foods to MyPyramid groups and dietary components, such as sodium, saturated fat, discretionary fats and oils, and calories from SoFAAS. We first sum the weighted amounts of MyPyramid groups, for example cup equivalents in the fruit group, provided by a specific subgroup of foods, such as fruit juice; fresh, canned, dried, and frozen fruit; or baby food, for all households or individuals in the sample. We then divide by the total weighted amount of the MyPyramid group in the foods used by NFSPS households or consumed by all individuals in NHANES.

For the fruit MyPyramid group, we find that a 10 percent increase in spending on food is associated with a 0.78 percentage point increase in the relative contribution of fruit (fresh, canned, dried, or frozen) to the MyPyramid Fruit Group for SNAP participants and a 0.68 percentage point increase for low-income individuals. Expenditures on fruit, as a percentage of total food expenditures identified in the CE-Diary data, are also positively associated with spending on food.

Figure IX.2 Change in Fruit Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

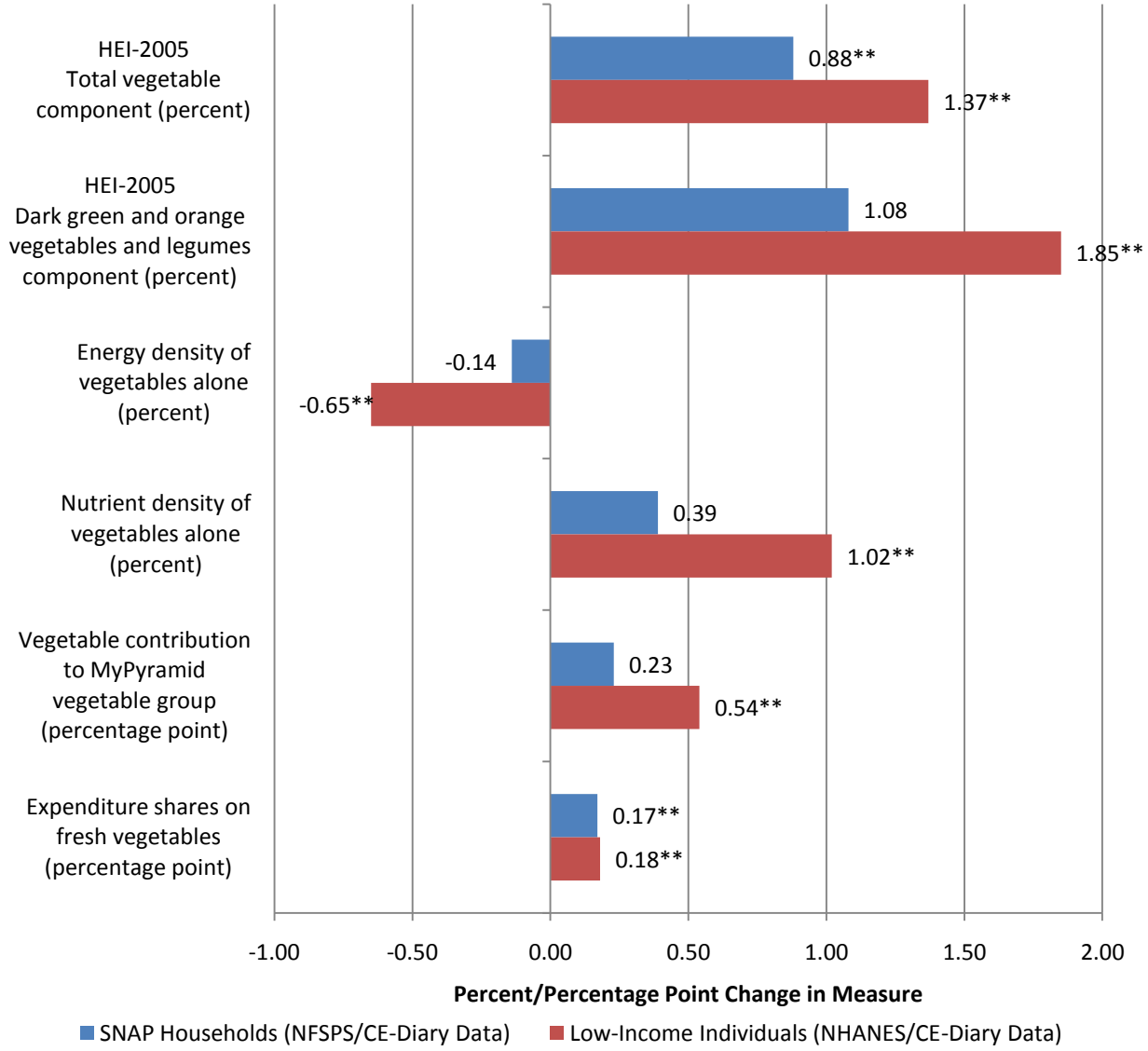
2. Vegetables

Increased spending on food is also associated with increased use and intake of vegetables, according to several of the measures (Figure IX.3). Among SNAP participant households, a 10 percent increase in spending on food is associated with an increase of 0.88 percent on the vegetable component of the HEI-2005; for low-income individuals, it is associated with a 1.37 percent increase in the score. For low-income individuals, a 10 percent increase in food spending is also

associated with a 0.65 percent decrease in energy density for vegetables and a 1.02 percent increase in nutrient density.

Low-income individuals with higher diet costs consume larger shares of vegetables (as opposed to mixed dishes and other contributors of vegetables) to contribute to their total MyPyramid vegetable group. Expenditures on vegetables, as a percentage of total food expenditures, are also positively associated with spending on food, increasing 0.17 and 0.18 percentage points for SNAP participants and low-income consumer units, respectively, with a 10 percent increase in expenditures.

Figure IX.3 Change in Vegetable Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

3. Grains

Results for grains are mixed, with both positive and negative findings (Figure IX.4). The HEI-2005 measure includes points based on both total grains and whole grains. A 10 percent increase on food spending is associated with a decrease in HEI-2005 component scores for grains for low-income individuals (-0.45 percent). The HEI-2005 component score for whole grains, which have seen more of a focus than total grains in recent public health discussions, show a larger decrease than total grains (-1.54 percent). In addition, SNAP participants with higher spending on food use grains that are more energy dense, that is, higher in calories per gram. However, the SNAP participants with higher spending use grains that are more nutrient dense (a 10 percent increase in food spending is associated with a 1.35 percent increase in nutrient density). Low-income individuals with higher diet cost consume a smaller share of total grains from grains and grain products, as opposed to frozen, carry-out, deli-prepared foods, sweets, desserts, and salty snacks, than those with lower diet cost.

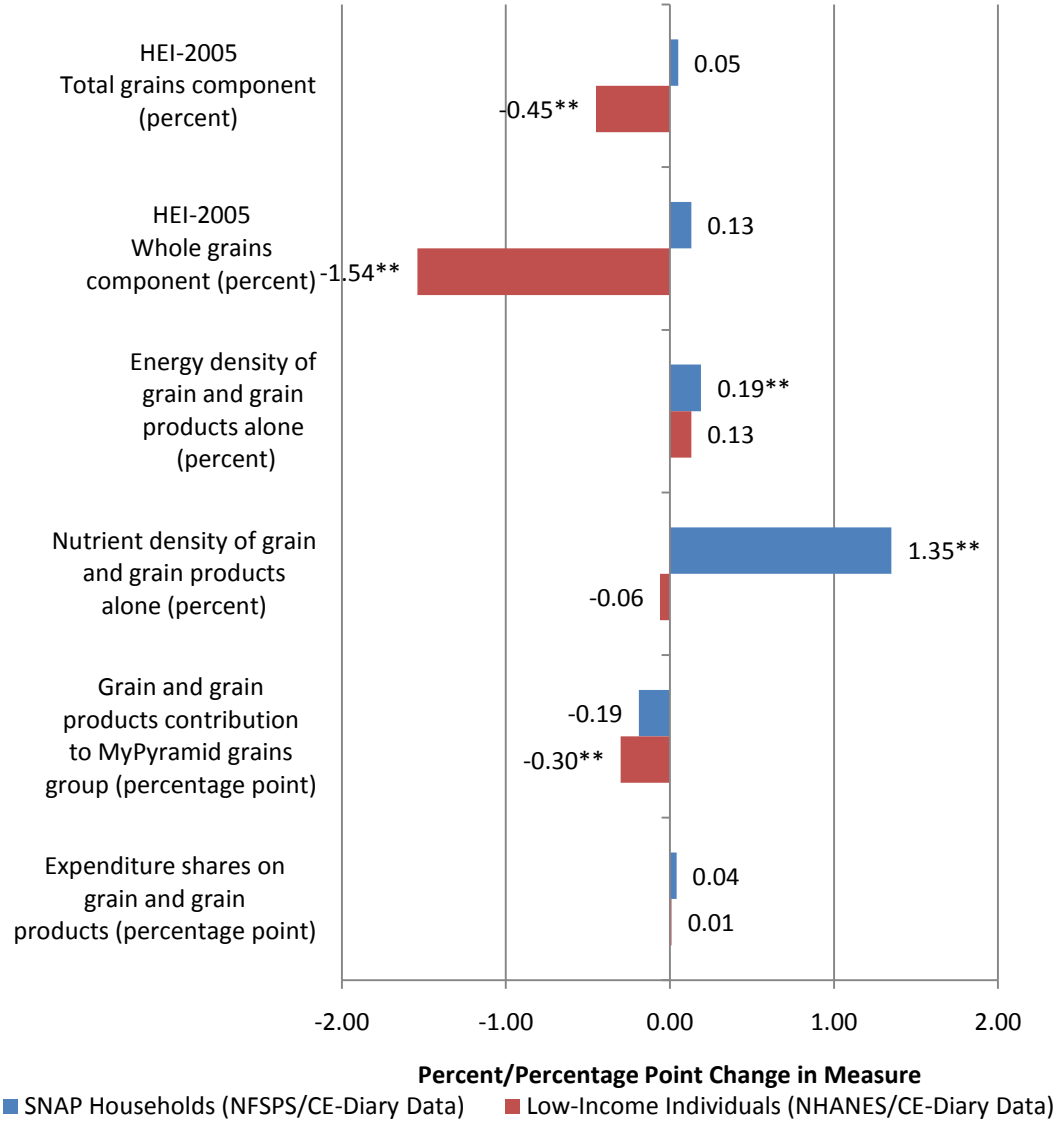
4. Dairy

Low-income individuals with higher diet cost have a higher HEI-2005 component score for milk than those with lower diet cost (Figure IX.5). They also consume milk and milk products that are higher in nutrient density (the energy density measure does not include liquids and so is not included here). However, they consume a smaller share of total milk from fluid milk than those with lower diet costs. As a percentage of expenditures on food, SNAP participants and low-income consumer units who spend more on food spend a higher proportion on high-fat dairy products and a lower proportion on other types of dairy products.

5. Desserts, Sweets, and Salty Snacks

The results for use and intake of desserts, sweets, and salty snacks are also mixed (Figure IX.6). A 10 percent increase in food spending is associated with a lower score on the HEI-2005 component for calories from SoFAAS for low-income individuals. For both SNAP participants and low-income individuals, more of the calories from SoFAAS come from sweets and desserts than for those who spend less on food. SNAP participants and low-income individuals who spend more on food also spend more on baked desserts and other desserts as a percentage of their total food spending than those who spend less on food. However, for both SNAP participants and low-income individuals, higher expenditures on food are associated with use and intake of desserts, sweets, and salty snacks that are higher in nutrient density.

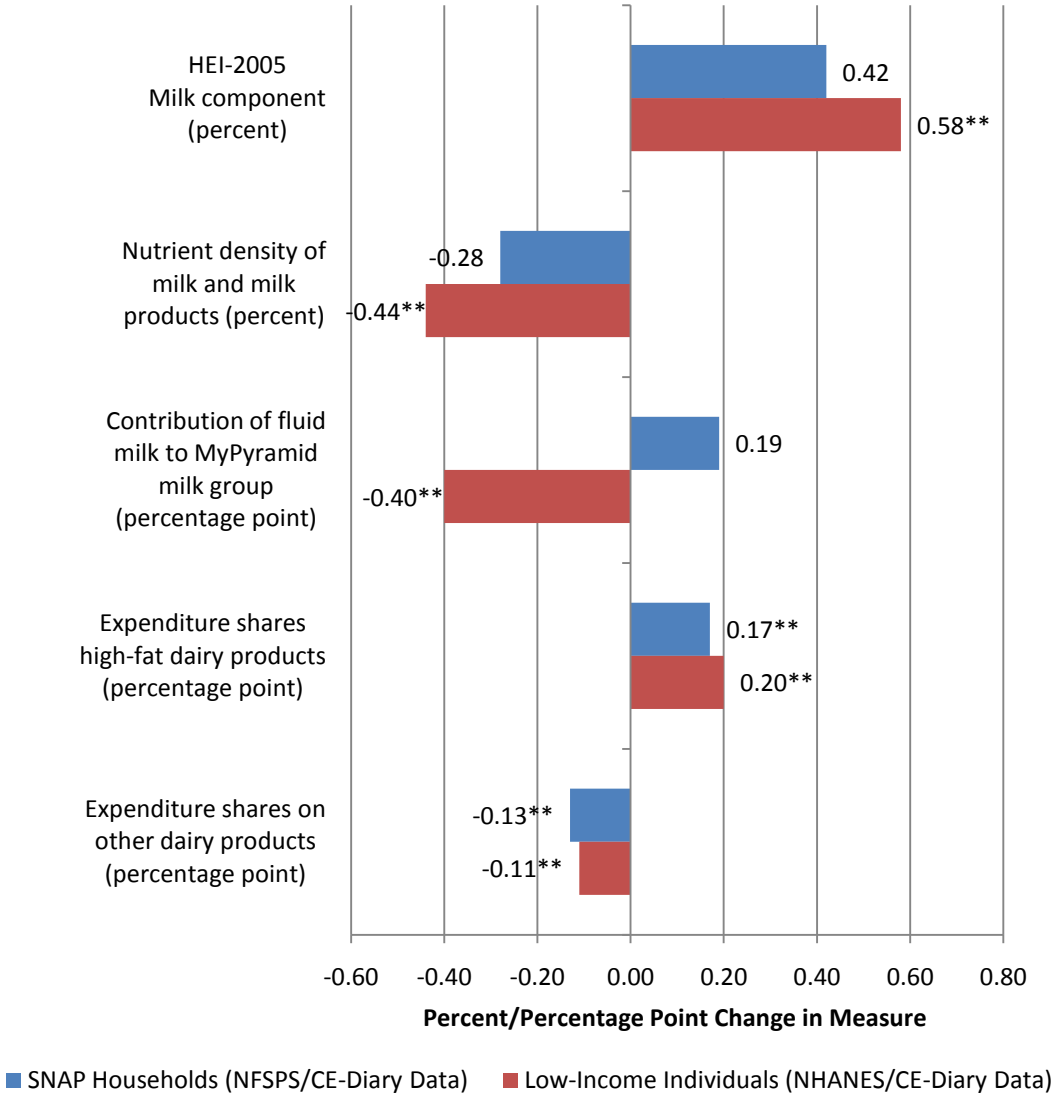
Figure IX.4 Change in Grain Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

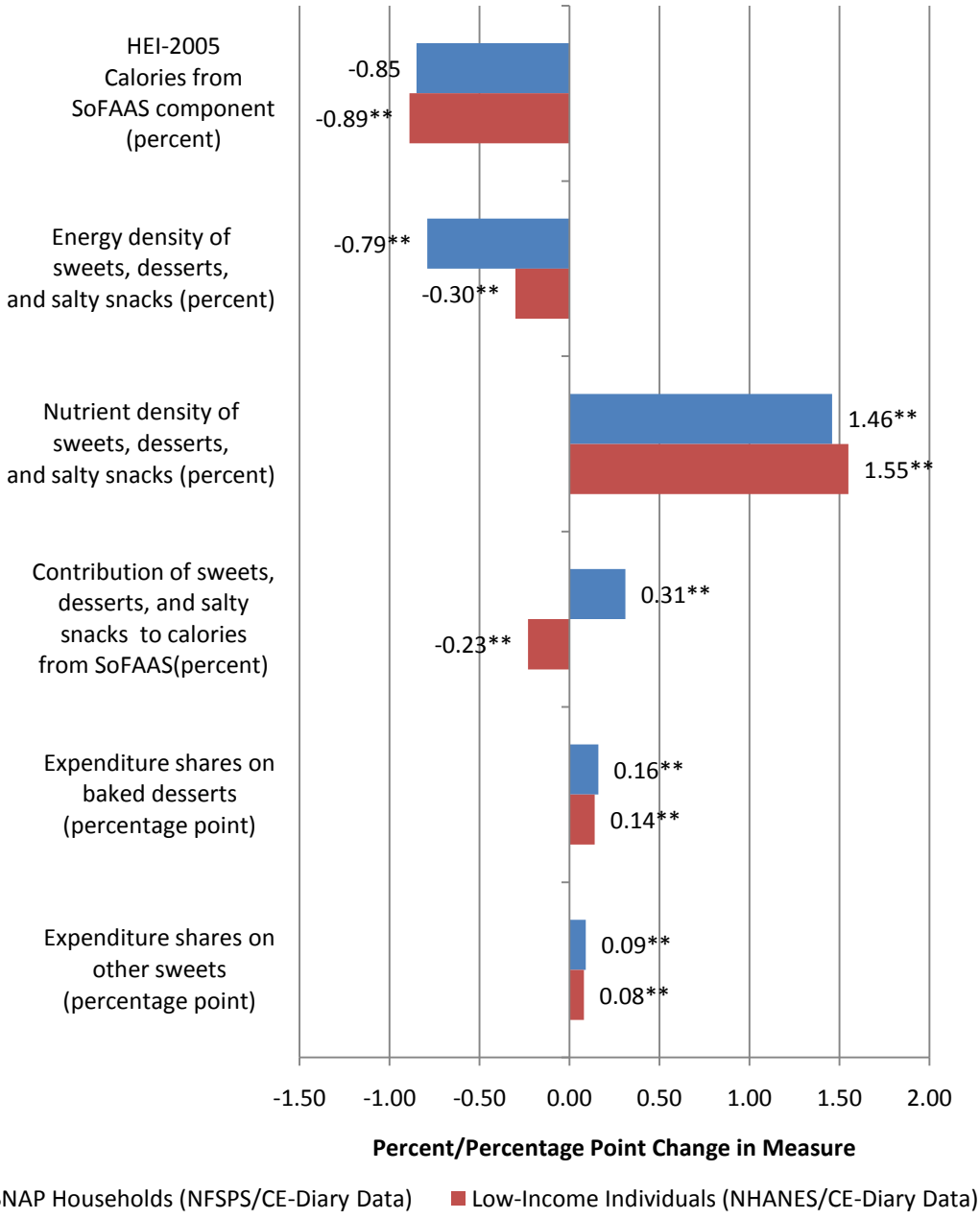
Figure IX.5 Change in Dairy Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

Figure IX.6 Change in Desserts, Sweets, and Salty Snacks Measures Associated with 10 Percent Increase in Food Expenditures, by Diet Quality Measure



Sources: SNAP participants for HEI–2005, energy density, nutrient density, and food shares from 1996 NFSPS data. Low–income individuals for HEI–2005, energy density, nutrient density, and food shares from 2001–2004 NHANES appended with price data. Expenditure shares from 2005 CE–Diary data.

Note: * or ** denotes statistically significant at the 0.05 or 0.01 level of significance, respectively.

C. Findings by Subgroup

We also examine associations between food spending and diet quality by several subgroups, including age, gender, education, and income. In many cases, the findings for subgroups mirror the

findings for the low-income population. Thus, we present selected results in the report, such as the following:

- Low-income children with higher diet cost have slightly higher intakes of iron per 1000 calories consumed than those with lower diet cost. Older adults with higher diet costs have lower intakes of iron than those with lower diet costs. The relationship is not statistically significant for non-elderly adults.
- Low-income children with higher diet cost consume less energy-dense vegetables and more energy-dense grains and grain products than low-income children with lower diet costs. None of these relationships was significant for adults.
- Low-income individuals with less than a high school education and high diet costs consume vegetables with lower energy density than those with low diet costs.
- Low-income individuals with income from 130 to 300 percent of poverty and high diet costs consume foods that are higher in nutrient density than those with low diet costs, as do low-income females and individuals who are married or living together.

D. Synthesis of Study Findings

Our basic analytic approach is to use person- and household-level data sets to examine associations between levels of food expenditures and scores on the various indices of diet quality. However, the research and policy implications of our findings are defined by a broader conceptualization of the factors which underlie interest in diet quality—the presumed effect of diet on health outcomes. Assessing this is important from a policy perspective because it is likely that it provides an intermediate measure of how nutrition policy may affect a wide range of health outcomes, including obesity, cardiovascular disease, diabetes, and other diseases.

The overarching goal for this line of research was to address a "link" in the causal chain that underlies the assumption that SNAP participation leads to improved dietary outcomes. It is well documented that SNAP leads households to spend more on food. The question this study sought to address is "Does spending more on food lead to a higher quality diet?" To answer this question, we explored the relationship between food expenditures and several different measures of diet quality using two different data sets that assessed diet quality at the household and individual levels.

The goal of this research was to determine how diet quality and food expenditures are related for SNAP participant households and, more generally, among low-income individuals. However, all findings must be interpreted with caution. To the extent that we find positive relationships for SNAP participants, the relationship is not necessarily causal, due to selection bias (factors that affect both expenditures and diet quality that are not accounted for in the model either because they are unobserved or are not available in the data).

It is also important to recognize that a failure to find a relationship between food expenditures and the quality of household food supplies does not necessarily prove that SNAP is powerless to improve dietary intake. Burstein et al. (2005) identified several factors that may affect the ability of the analysis to detect an effect, including: (1) small sample sizes; (2) measurement error (associated with collecting the food use data and translating these data into nutrient equivalents); and (3) sampling variability associated with the small samples of data on foods withdrawn from

household supplies. These data characteristics may obscure the relationship between food expenditures and diet quality.

As shown in Figure IX.1, our findings are striking in their consistency across outcome measures and data sets. We find a positive and significant relationship between food expenditures and diet quality across all outcome measures and data sets used in the analysis. For some outcome measures such as the HEI-2005, the magnitudes of the associations are similar in both the NFSPS and NHANES. For others, like energy density and nutrient density, the associations are larger in the NFSPS than in the NHANES. In addition, supplementary analyses examining the relationship for subgroups defined using household or individual characteristics such as participation in SNAP or defined using subgroups of food categories such as fruits or vegetables showed a close correspondence among results from difference data sets in some cases. However, in other cases, an association was found in only one of the two data sets. While the analyses based on the NFSPS and NHANES are similar, several important differences between the two data sets warrant caution in comparing results across the two surveys, including units of observation, dietary recall period, and year of data collection.

Results consistently show that increasing spending on food leads to an increase in overall diet quality; but the increased spending appears to explain only a small portion of the variation in diet quality scores. Moreover, the increase in the extra amount spent on food may only lead to a slight improvement in the total nutritional value of a household's diet. For example, increasing a household food budget by 10 percent may only lead to a 1 percent increase in that household's overall nutritional intake. This means that a person who already consumes an average quality diet might only improve his or her diet marginally from the average. Finally, increasing the household food budget by more than 10 percent may lead to a larger improvement in diet quality, although the improvement may not be proportional. For example, increasing the food budget by 20 percent, versus 10 percent, may not lead to twice the improvement in diet quality.

These findings beg the question of how meaningful these relationships between food expenditures and diet quality are from an economic, nutrition, or health policy perspective. Conceptually, it would be desirable to explicitly link the observed diet quality variables to health outcomes, particularly when assessing the sizes of observed associations in the data. FNS has moved in this direction with their Strategic Plan for 2005-2010, which sets a goal to increase mean HEI scores among individuals with incomes below 130 percent of poverty from 62.0 to 65.8, a 6 percent increase (USDA 2006).[55] Our results show that a 10 percent increase in food expenditures increases the HEI-2005 score by about one-third of a percent, or 5 percent toward the stated goal. Given that the mean amount of household expenditures on food per week was $59.13 in 1996 (one of the two survey periods on which our analysis is based), a 10 percent increase in expenditures translates into an extra $6 per week or $26 per month.

We found larger percentage increases in some of the individual HEI-2005 component scores. For example, a 10 percent increase in food expenditures increases the HEI-2005 component score for whole fruit by 3 percent. These results suggest that policies targeting increased expenditures on specific types of foods may go further in improving diet quality.

[55] This goal was based on the original HEI rather than the HEI-2005 used in the current study.

In summary, the findings of this study consistently show that food expenditures and diet quality are associated for SNAP households and low-income individuals. The assessment is based on a comprehensive set of findings, based on multiple data sets from several survey periods and a rich set of more than a half-dozen dietary quality measures. While these are strong associations in a statistical sense, it is difficult to say whether they are "small" or "large" from a nutrition or health policy perspective. Additional research (which was outside the scope of work for this project) is needed to document the link between diet quality and health outcomes for this population through a comprehensive literature review.

REFERENCES

Burstein, N., W. Hamilton, M.K. Fox, C. Price, and M. Battaglia. "Assessing the Food Security and Diet Quality Impacts of FNS Program Participation: Final Menu of Survey Options." Cambridge, MA: Abt Associates, Inc., 2005.

Carriquiry, Alicia L. "Assessing the Prevalence of Nutrient Inadequacy." *Public Health Nutrition*, vol. 2, 1999, pp. 23–33.

Cole, Nancy and Mary Kay Fox. "Diet Quality of Americans by Food Stamp Participation Status: Data from the National Health and Nutrition Examination Survey, 1999-2004." Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, July 2008.

Cohen, Barbara, James Ohls, Margaret Andrews, Michael Ponza, Lorenzo Moreno, Amy Zambrowski, and Rhoda Cohen. "Food Stamp Participants' Food Security and Nutrient Availability." Report submitted to the U.S. Department of Agriculture. Princeton, NJ: Mathematica Policy Research, Inc., July 1999.

Cook, A.J., and J.E. Friday. "Pyramid Servings Database for USDA Survey Food Codes Version 2.0 (PyrServDB_v2), 2004." Beltsville, MD: CNRG. Available at [www.ba.ars.usda.gov/cnrg].

Currie, Janet, and Jeffrey Grogger. 2001. "Explaining Recent Declines in Food Stamp Program Participation." in *Brookings-Wharton papers on Urban Affairs, 2001*. Washington, DC: The Brookings Institution.

Drewnowski, A. "Concept of a Nutrition Food: Toward a Nutrient Density Score." *American Journal of Clinical Nutrition*, vol. 82, 2005, pp. 721-732.

Drewnowski, A., and S.E. Specter. "Poverty and Obesity: The Role of Energy Density and Energy Costs. *American Journal of Clinical Nutrition*, vol.79, 2004, pp. 6-16.

Fraker, T. "The Effects of Food Stamps on Food Consumption: A Review of the Literature." Alexandria, VA: U.S. Department of Agriculture, Food and Nutrition Service, October 1990.

Freedman, L.S., Guenther, P.M., Krebs-Smith, S.M., & Kott, P.S. "A population's mean Healthy Eating Index-2005 scores are best estimated by the score of the population ratio when one 24-hour recall is available." *Journal of Nutrition, 138,* 1725-1729, 2008.

Friday, J.E., and S.A. Bowman. FoodLink Pyramid Database Series, MyPyramid Equivalents Database for USDA Survey Food Codes, version 1.0. Released online, 2006. Available at [www.ba.ars.usda.gov/cnrg].

Guenther, Patricia M. "Development and Evaluation of the Healthy Eating Index-2005." Washington, DC: U.S. Department of Agriculture, Center for Nutrition and Policy Promotion, 2007a.

Guenther, P. Verbal communication, April 25, 2007b.

Institute of Medicine. *The Dietary Reference Intakes: The Essential Guide to Nutrient Requirements*. Washington, DC: National Academies Press, 2006.

Institute of Medicine. *Dietary Reference Intakes: Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids*. Washington, DC: National Academies Press, 2002/2005.

Institute of Medicine. *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington, DC: National Academy Press, 2000.

Kenney, Genevieve and Jennifer Pelletier. "Setting Income Thresholds in Medicaid/SCHIP: Which Children Should Be Eligible?" Washington, DC: The Urban Institute, January 2009.

Ledikwe, J.H., H.M. Blanck, L. Kettle Kahn, et al. "Dietary Energy Density Determined by Eight Calculation Methods in a Nationally Representative United States Population." *Journal of Nutrition*, vol. 135, 2005, pp. 273-278.

Meyer, Bruce D., and James X. Sullivan. "Measuring the Well-Being of the Poor Using Income and Consumption." Paper presented at the Joint IRP/ERS Conference on Income Volatility and Implications for Food Assistance, Washington, DC, May 2-3, 2002. Modified March 2003.

Tobin, J. "Estimation of Relationships for Limited Dependent Variables." *Econometrica,* vol 26, 1958, pp. 24-36.

U.S. Department of Agriculture. "MyPyramid Food Guidance System." Available at [www.mypyramid.gov]. Accessed July 10, 2007b.

U.S. Department of Agriculture. "Healthy Eating Index-2005." U.S. Department of Agriculture, Center for Nutrition Policy and Promotion, CNPP Fact Sheet No. 1, December 2006.

U.S. Department of Agriculture. "Strategic Plan for FY 2005-2010." U.S. Department of Agriculture, 2006.

U.S. Dietary Guidelines Advisory Committee. "2005 Dietary Guidelines Advisory Committee Report." Washington DC, August 2004.

U.S. Department of Health and Human Services and U.S. Department of Agriculture. *Dietary Guidelines for Americans, 2005*. 6th Edition. Washington, DC: U.S. Government Printing Office, January 2005.

www.mathematica-mpr.com

Improving public well-being by conducting high-quality, objective research and surveys

Princeton, NJ ■ Ann Arbor, MI ■ Cambridge, MA ■ Chicago, IL ■ Oakland, CA ■ Washington, DC