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Fruit and Vegetable Consumption by Low-Income Americans

Would a Price Reduction Make a Difference?

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Fruit and Vegetable Consumption by Low-Income Americans

Would a Price Reduction Make a Difference?

Diansheng Dong and Biing-Hwan Lin

Abstract

Americans' diets, particularly those of low-income households, fall short of Government recommendations in the quantity of fruits and vegetables consumed. Some proposals suggest that a price subsidy for those products would encourage low-income Americans to consume more of them. This study estimated that a 10-percent subsidy would encourage low-income Americans to increase their consumption of fruits by 2.1-5.2 percent and vegetables by 2.1-4.9 percent. The annual cost of such a subsidy for low-income Americans would be about $310 million for fruits and $270 million for vegetables. And most would still not meet Federal dietary recommendations.

Keywords: Price subsidy, demand elasticity, food consumption, fruits and vegetables, low income, Homescan Data, Supplemental Nutrition Assistance Program (SNAP), National Health and Nutrition Examination Survey (NHANES), and MyPyramid

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Contents

Summary

Deficiencies exist in Americans' diets. These dietary deficiencies may contribute to several types of chronic diseases, which in turn may impose large economic costs on individuals and society. Dietary deficiencies are worse among low-income Americans. Many intervention strategies, however, are under consideration by government and health advocates to improve Americans' diets.

What Is the Issue?

One strategy to encourage low-income Americans to eat more nutritious diets is for the Government to subsidize the consumption of healthful foods, such as fruits and vegetables, or tax the consumption of less healthful foods, such as salty snacks. This report estimates recent consumption levels of fruits and vegetables, the effects of a price subsidy for low-income households on their consumption, and the associated cost.

What Did the Study Find?

American diets continued to fall short of the recommended consumption levels of fruits and vegetables. On average, Americans consumed 1.03 cups of fruits and 1.58 cups of vegetables per day in 2004, compared with the recommended 1.80 cups of fruits and 2.60 cups of vegetables. Individuals eligible for benefits through the Supplemental Nutrition Assistance Program (low-income consumers) ate even smaller amounts of fruits and vegetables—0.96 cup of fruits and 1.43 cups of vegetables.

Using a range of price elasticities and estimates of food consumption by low-income Americans, Economic Research Service calculated that a 10-percent price discount at the retail level would encourage low-income households to increase their consumption of fruits by 2.1 to 5.2 percent (from 0.96 cup to 0.98-1.01 cups) and vegetables by 2.1 to 4.9 percent (from 1.43 cups to 1.46-1.50 cups).

In 2004, low-income households spent $3.91 billion on fruits and $3.71 billion on vegetables at retail outlets. Discounting the prices of fruits and vegetables by 10 percent for low-income households would cost the Government, on average, about $308 million per year for fruits (7.9 percent of recent expenditures on fruits by low-income Americans) and $274 million for vegetables (7.4 percent of recent expenditures on vegetables by low-income Americans).

How Was the Study Conducted?

A statistical model was estimated and empirical literature reviewed to obtain a range of demand elasticities for fruits and vegetables. The statistical model used 2004 Nielsen Homescan data to estimate consumers' responses to price changes for fruits and vegetables by income groups. The literature review focused mainly on recently published journal articles and reports that documented demand elasticities. The 1999-2002 National Health and Nutrition Examination Survey (NHANES) data allowed for comparison of food

consumption against the 2005 Federal dietary recommendations and estimates of food consumed at home and away from home. USDA's MyPyramid Equivalent Database was used to convert food consumption reported in NHANES to the unit and food groups specified in the 2005 *Dietary Guidelines for Americans*. Data from the 2004 Bureau of Labor Statistics Consumer Expenditure Diary Survey (issued in 2006) were used to estimate food spending by households of different income levels. The cost of the price subsidy was derived using estimates of food spending and demand elasticities. Administrative costs were not considered.

Introduction

In the United States, high intake of fat and saturated fat and low intake of fiber- and calcium-containing foods—such as fruits, vegetables, whole grains, and low-fat milk—have been associated with diseases such as coronary heart disease, cancer, stroke, diabetes, hypertension, obesity, and osteoporosis (Frazao, 1999). These diet-related health problems are costly to society. Diet-related, premature deaths from coronary heart disease, cancer, stroke, and diabetes accounted for 5.3 percent of all deaths in the United States, costing the U.S. Government $71 billion in 1995 (Frazao, 1999).

To improve diets, the U.S. Government has issued guidelines for healthy eating since 1894 and published the *Dietary Guidelines for Americans* every 5 years since 1980. Most Americans, however, do not follow this advice. From 1999 to 2000, only 10 percent of Americans met the dietary recommendations, while 90 percent did not (Basiotis et al., 2002). Diets are particularly deficient among low-income Americans, especially in regard to their consumption of fruits and vegetables (Lin, 2005; Basiotis et al., 2002).

Health advocates and the Government are considering a number of intervention strategies to encourage low-income Americans to consume more low-calorie and high-nutrient foods. One such strategy would be to subsidize the consumption of healthful foods, such as fruits and vegetables, or tax the consumption of less healthful foods, such as salty snacks (Guthrie et al., 2007; Kuchler et al., 2005).

What is the likely effect on consumption if fruit and vegetable prices were lowered for low-income households? To answer this question, we first examined recent levels of consumption in households of varying income levels, paying special attention to low-income households. A price subsidy program, if effective, should raise consumption in these households. We next estimated price elasticities of demand for fruits and vegetables. These estimates are specific to low-income households and reveal the potential change in consumption if food prices were subsidized (reduced) by certain amounts. We considered subsidies of 5 percent, 10 percent, and 20 percent. Predicted levels of consumption from the subsidy program were compared with recent consumption as well as current dietary guidelines. Finally, we estimated the direct cost to the Government of implementing such a subsidy program. The net benefit of the subsidies and the administrative costs, however, were not estimated.

Recent Levels of Fruit and Vegetable Consumption by Low-income Americans

We used the National Health and Nutrition Examination Survey (NHANES) to estimate recent levels of fruit and vegetable consumption. The Centers for Disease Control and Prevention publishes NHANES with supporting documentation on its Web site (CDC, 2005). For this survey, individuals are asked to report their consumption of foods and beverages over a 24-hour period. We analyzed data from the 1999-2002 NHANES for which 18,305 individuals had completed single-day dietary records. We excluded children younger than 2 years of age and pregnant women (who have different dietary needs), yielding a sample of 17,074 individuals.

The database developed by the Community Nutrition Research Group (CNRG) at USDA's Agricultural Research Service provided additional information to estimate the quantities of fruits and vegetables consumed by NHANES respondents. Survey respondents may consume foods "as-is" (e.g., a whole apple) or as an ingredient in food (e.g., apple pie filling). The MyPyramid Equivalents Database provided conversion factors, which translate the amount of food eaten, whether a slice of apple or a piece of pie, into cups or ounces (USDA/CNRG, 2006).

For this report, we placed the NHANES participants into three groups based on their household incomes and Federal poverty guidelines. The low-income group included households with an income up to 130 percent of the poverty level (the income cutoff above which households are ineligibile for benefits through the Supplemental Nutrition Assistance Program). The middle-income group's household income was 131-300 percent of the poverty level, and the high-income group's household income was above 300 percent of the poverty level.

We then compared recent levels of consumption with recommendations from the 2005 *Dietary Guidelines for Americans* (see box, "The U.S. Dietary Guidelines"). Recommended levels of fruit and vegetable consumption for an individual are calculated based on how many calories a person consumes. Among individuals in the NHANES sample, caloric intake averaged 2,164 calories per day. An individual taking in that many calories per day should consume 2.6 cups of vegetables and 1.8 cups of fruit (table 1).

Vegetable Consumption

The dietary recommendations for applied caloric intake in 1999-2002 called for Americans to consume an average of 2.6 cups of vegetables per day, distributed as follows:[1]

- 0.35 cup of dark green vegetables;
- 0.25 cup of orange vegetables;
- 0.68 cup of starchy vegetables; and
- 1.32 cups of other vegetables (including legumes and tomatoes).

The actual daily consumption for this period, as measured by NHANES, averaged 1.58 cups of vegetables—61 percent of the recommended amount. Consumption of dark green and orange vegetables was especially low.

[1]Dark-green vegetables: arugula, balsam-pear tips, beet greens, bitter melon leaves, broccoli, chard, chicory, cilantro, collard greens, cress, dandelion greens, endive, escarole, grape leaves, kale, lambsquarters, mustard greens, mustard cabbage, parsley, poke greens, pumpkin leaves, romaine lettuce, spinach, sweet potato leaves, taro leaves, turnip greens, and watercress. Orange vegetables: calabaza, carrots, carrot juice, pumpkin, sweet potato, winter squash, and yams (MyPyramid Equivalents Database for USDA Survey Food Codes, 1994-2002).

The U.S. Dietary Guidelines

Federal dietary recommendations date back to 1894 (Davis and Saltos, 1999). Early food guides focused on the need to ingest enough nutrients. By the 1970s, growing evidence of health problems caused by excessive intake of certain foods required that the dietary recommendations also emphasize avoiding excessive intake of fat, saturated fat, cholesterol, and sodium.

Responding to the need for authoritative, consistent guidance on diet and health, the U.S. Department of Agriculture (USDA) and U.S. Department of Health and Human Services (HHS) have jointly issued dietary guidelines every 5 years since the first edition of *Nutrition and Your Health: Dietary Guidelines for Americans* was published in 1980. The guidelines recommended consuming a variety of foods to provide essential nutrients, while maintaining recommended body weight and moderating intake of fat, saturated fat, cholesterol, and sodium. With the 1990 edition of the *Dietary Guidelines,* quantitative dietary goals were also issued. In 1992, USDA released the Food Guide Pyramid to help consumers put the *Dietary Guidelines* into action. The Pyramid specified recommended consumption at three levels of caloric intake for each of five food groups:

1. Bread, cereal, rice, and pasta;
2. Vegetables;
3. Fruits;
4. Milk, yogurt, and cheese; and
5. Meat, poultry, fish, dry beans, eggs, and nuts.

The 2005 *Dietary Guidelines* encouraged Americans to consume more fruits, vegetables, whole grains, and dairy products (USDA/DHHS, 2005). For the first time, the recommendations for vegetables specified types of vegetables, while the recommendations for grain products were separated into refined and whole grains.

Notable findings by type of vegetable include (table 1):

- Americans consumed, on average, 26 percent (0.09 cup) of the recommended amount of dark green vegetables. Individuals in the low-income group consumed 18 percent (0.06 cup) versus 23 percent for members of the middle-income group (0.08 cup) and 33 percent for people in the high-income group (0.12 cup);
- Americans as a whole consumed 32 percent (0.08 cup) of the recommended amount of orange vegetables with low-income households consuming even less—29 percent (0.07 cup). The high-income group consumed 33 percent (0.09 cup) of the recommended amount;

Table 1

1999-2002 food intake compared with 2005 Dietary Guidelines for fruits and vegetables by income level

Item	Total	Income level[1]		
		Low-income	Middle-income	High-income
Sample size (number)	17,074	7,303	4,789	4,982
Daily energy intake (kilocalorie)	2,164	2,059	2,152	2,250
		Cups		
Average daily intake				
Total vegetables	1.58	1.43	1.54	1.72
Dark green	0.09	0.06	0.08	0.12
Orange	0.08	0.07	0.07	0.09
Starchy	0.47	0.46	0.48	0.47
White potatoes[2]	0.40	0.39	0.40	0.40
Other	0.94	0.83	0.91	1.03
Tomatoes	0.32	0.29	0.32	0.35
Legumes	0.11	0.12	0.11	0.09
Total fruits	1.03	0.96	0.96	1.14
Average recommended consumption[3]				
Total vegetables	2.60	2.48	2.58	2.71
Dark green	0.35	0.34	0.35	0.36
Orange	0.25	0.24	0.25	0.27
Starchy[2]	0.68	0.64	0.67	0.72
Other[4]	1.32	1.26	1.31	1.37
Total fruits	1.80	1.74	1.79	1.86
Ratio of average intake to average recommendation		*Percent*		
Total vegetables	60.77	57.66	59.69	63.47
Dark green	25.71	17.65	22.86	33.33
Orange	32.00	29.17	28.00	33.33
Starchy	69.12	71.88	71.64	65.28
White potatoes[2]	58.82	60.94	59.70	55.56
Other[3]	71.21	65.87	69.47	75.18
Total fruits	57.22	55.17	53.63	61.29

[1] The low-income group has income up to 130 percent of the poverty level, the middle-income group has income 131-300 percent of poverty level, and the high-income group has income 300 percent or more of poverty level.

[2] The ratio is the potato intake to the recommendation for total starchy vegetables.

[3] The numbers of consumption and recommendation in this table are weighted averages over individuals under different income categories. For example, if only two people with equal sample weights existed in the low-income category, one consumes 1,800 calories per day and the other consumes 2,600 calories per day. According to the 2005 *Dietary Guidelines,* they should consume 1.5 and 2 cups of fruits, respectively. The weighted average recommendation for fruits is 1.75 cups for them.

[4] Includes tomatoes and legumes.

Source: Economic Research Service calculations based on the National Health and Nutrition Examination Survey data.

- Americans consumed, on average, 69 percent (0.47 cup) of the recommended amount of starchy vegetables—mostly white potatoes. Consumption from low- and middle-income households was closer to guidelines at 72 percent than high-income households (65 percent);

- Americans consumed, on average, 71 percent (0.94 cup) of the recommended amount of "other" vegetables of which tomatoes contributed 0.32 cup—mainly from ketchup and tomato sauce. Members of low-income households deviated furthest from guidelines, consuming 66 percent of the recommended quantity of these vegetables (0.83 cup), compared with middle- (69 percent) and high-income (75 percent) households.

Fruit Consumption

Americans consumed 1.03 cups of fruits per day from 1999 to 2002, 57 percent of the recommended 1.8 cups. Low-income individuals consumed 55 percent of the daily recommendation (0.96 cup). Members of middle- and high-income households consumed 54 percent (0.96 cup) and 61 percent (1.14 cups), respectively. MyPyramid does not break down fruit consumption by type of fruits as it does for vegetables.

Low-Income Americans May Respond to Price Changes for Fruits and Vegetables

To estimate the impact of a price subsidy program, we need to know how consumers react to a price change for fruits and vegetables. In other words, we need to know the price elasticity of demand. Price elasticity is defined as the percentage change in the quantity demanded for a product given a 1-percent change in the price of the product. As the price of a food increases (decreases), its demand normally declines (rises) so that the price elasticity is expected to be negative. Demand is elastic, unitary elastic, and inelastic when the percentage change in quantity demanded is greater than, equal to, or less than the percentage change in the magnitude of price.

The effect of a pricing strategy, such as a tax, subsidy, or coupon, depends on price elasticities. Obtaining household price elasticities for fruits and vegetables is key to our analysis. To do that, we estimated the demand for fruits and vegetables using data from Nielsen's 2004 Homescan Consumer Panel. Households participating in Nielsen's panel report their food purchases for at-home consumption, including foods bought on both a Universal Product Code (UPC) and random weight basis. Our statistical model allows the quantities of fruits and vegetables purchased by a household to vary with the household's income and demographic characteristics. Separate elasticities were calculated for our population of primary interest, low-income households (below 130 percent of poverty), and other households (above 130 percent of poverty).

We estimated price elasticities for all types of at-home fruit and at-home vegetable purchases. To define these two food categories, we aggregated each household's purchases of fruits or vegetables in all forms. That is, we calculated the total quantity of fruits and vegetables, including fresh, frozen, dried, and canned foods, for each household in our Homescan Data. We considered different possibilities for a price subsidy program and assumed that any subsidy would be applied to all aggregated at-home fruit and at-home vegetable purchases, as opposed to only a particular type of fruit or vegetable, such as apples or lettuce.

The statistical models developed for this analysis considered only how aggregate fruit and vegetable consumption may rise or fall. They did not account for potential changes in the consumption of other foods or the spending in nonfood categories. If vegetable prices decline, for example, households may eat less of other foods, such as meats or bakery products, as they would be relatively more expensive. Other types of foods, however, may complement vegetable consumption. Ground beef, buns (bread), lettuce, and tomatoes, for example, are commonly eaten together in a hamburger. Lower prices for lettuce and tomatoes might encourage households to purchase more ground beef and breads.

The total impact on dietary health due to a change in fruit and vegetable prices would depend on how Americans adjusted their overall diets. To address this broader question, it would be necessary to estimate the consumption of each type of food in a complete demand system. That is beyond the scope of our study. We instead estimated single-equation models in which

fruit and vegetable consumption depended only on their own prices. We assumed that prices for other foods would remain unchanged. This assumption should not affect our results as long as a subsidy program for fruits and vegetables does not change prices for other foods. While households may adjust their consumption of other types of foods, we assumed that eating more fruits and vegetables would be associated with healthier diets overall. A similar model was presented in the literature by Dong et al. (1998). For a brief description of our model, see "Appendix: Estimating Price Elasticity of Demand."

We found that low-income households increased their purchases of fruits and vegetables when prices for these foods were lowered. Our elasticity estimate for fruits is -0.52 and -0.69 for vegetables. If fruit and vegetable prices were reduced by 1 percent, we estimated that the demand for these foods would increase by 0.52 and 0.69 percent, respectively. Similarly, if prices were lowered by 10 percent, we estimated that households would increase their fruit purchases by 5.2 percent and their vegetable purchases by 6.9 percent. Demand was inelastic, meaning the quantities consumed will increase by a smaller percentage than the percentage decrease in price.

To compare our estimates, we conducted a review of existing studies on elasticities for fruits and vegetables. This range of estimates produced by different researchers helped us capture the range of possible effects that a policy may have on consumption (tables 2-4).

For aggregated fruits and vegetables, two studies, Park et al. (1996) and Huang and Lin (2000), reported price elasticities for low-income households. The elasticity estimates by Park et al. are -0.34 for fruits and -0.32 for vegetables based on the 1987-88 National Food Consumption Survey

Table 2
Demand elasticities for aggregated fruits and vegetables

			Fruits		Vegetables		
Source	All produce	All processed	Aggregated	Fresh	Aggregated	Fresh	Processed
Huang (1993)		-0.29		-0.20			-0.13
Brandow (1961)			-0.60			-0.30	
Cox and Wohlgenant (1986)						-0.20	-0.20 (canned) -0.67 (frozen)
Park et al. (1996)			**-0.34** (-0.52)		**-0.32** (-0.45)		
Raper et al. (2002)	**-1.00** (-0.98)						
Huang and Lin (2000)			**-0.65** (-0.75)		**-0.70** (-0.71)		
Dong and Lin[1]			**-0.52** (-0.58)		**-0.69** (-0.57)		

Note: Numbers in parentheses are for high-income households, the numbers in bold are for low-income households, and other numbers are for all households (not segmented by income).

[1] Data based on the findings from this report.

Source: Economic Research Service calculations based on each of the listed research reports.

Table 3
Demand elasticities for individual fruits

Source	Fresh						
	Apple	Banana	Grapefruit	Grape	Orange	Others	All processed
Huang (1993)	-0.19	-0.50	-0.45	-1.18	-0.85		
You et al. (1996, 1997)	-0.16	-0.42	-1.02	-0.91	-1.14	-0.28 ~ -0.96	
George and King (1971)	-0.72	-0.61			-0.66	-0.60	-0.76 ~ -1.00
Brown and Lee (2002)	-0.52	-0.54		-0.56	-0.67		-0.18 ~ -1.03

Note: Elasticities from multiple studies are listed individually, and elasticities from a single study are grouped into ranges.

Source: Economic Research Service calculations based on each of the listed research reports.

Table 4
Demand elasticities for individual vegetables

Source	Fresh							
	Carrot	Celery	Lettuce	Onion	Potato	Tomato	Others	All processed
Huang (1993)	-0.53	-0.08	-0.09	-0.21		-0.62	-0.53	
You et al. (1996, 1997)	-0.43	-0.05	-0.01	-0.18	-0.18	-0.41	-0.43	
George and King (1971)	-0.50		-0.14	-0.25	-0.31	-0.38	-0.50	-0.18 ~ -1.03

Note: Elasticities from multiple studies are listed individually, and elasticities from a single study are grouped into ranges.

Source: Economic Research Service calculations based on each of the listed research reports.

(NFCS). Using the same data, Huang and Lin reported estimates of -0.65 and -0.70, respectively. Though the data used by the two studies are the same, different models and estimation procedures caused the results to vary. It is impossible to judge which study gives better results. Our estimates for fruits (-0.52) and vegetables (-0.69) from Nielsen Homescan data were close to the latter results. We all found inelastic demands for fruits and vegetables. Our approach here was to use the maxima and minima of the three sets of elasticity estimates to evaluate the effect of a price discount.

As shown in tables 2-4, we found the following:

- Most elasticities were inelastic, which implies that a consumer's reaction to a price change would be slight; and

- Price elasticities for individual products were more elastic than those for the aggregate, indicating that a price discount would have more effect on individual products than on all products.

Elasticities from the literature show that low-income households are less responsive to price changes for fruits and vegetables (table 2). This pattern does not hold for all food groups examined. Our elasticity estimates show that low-income households are more responsive to price changes for vegetables, but less responsive for fruits. Further research is needed to clarify this question.

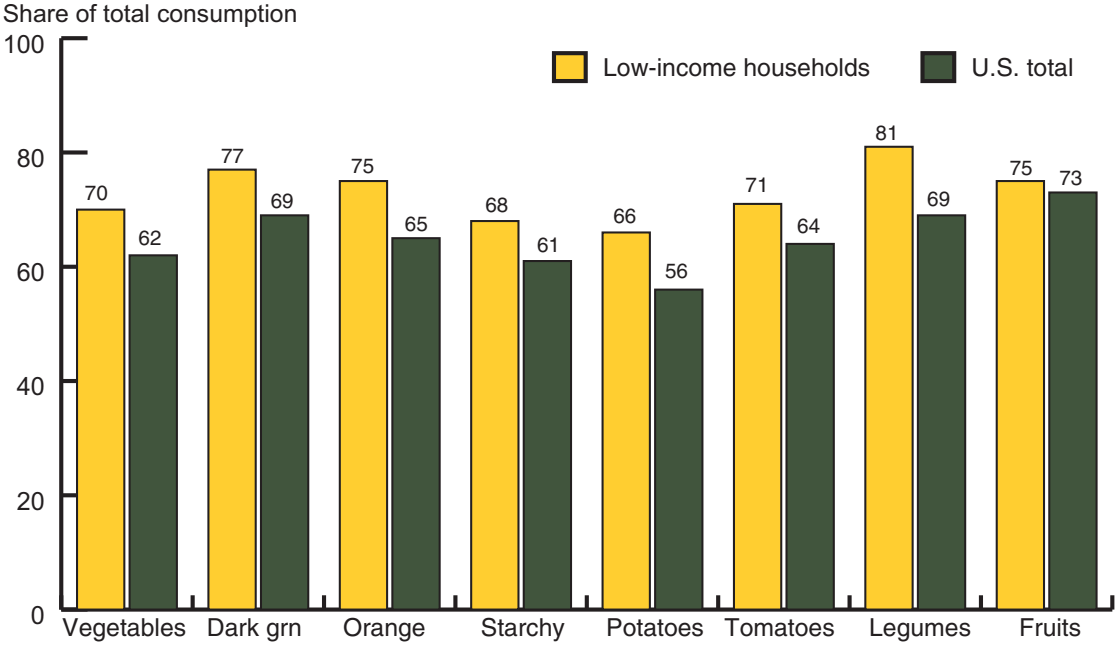
The Consumption Effects of a Price Subsidy for Low-Income Americans

With proper economic incentives, low-income Americans could be encouraged to consume more healthful foods, such as fruits and vegetables. This study examined the impact of a price discount on low-income households' purchases of fruits and vegetables. We assumed a certain percentage discount on purchases of fresh and processed fruits and vegetables at retail outlets for households who are income-eligible for the Supplemental Nutrition Assistance Program—that is, households with an income below 130 percent of Federal poverty guidelines (HHS, 2007). We also assumed that such subsidies would be targeted at the retail market for the food in question (e.g., apples), but not for a mixture containing the food (apple pie), nor at a commercial foodservice establishment. This assumption may have caused us to underestimate the price effect on consumption levels.

Since we assumed that any subsidy would be applied only to foods consumed at home, we expected consumption of these foods alone to increase. In the 1999-2002 NHANES, respondents reported whether they ate food at home or away from home. Figure 1 shows the share of fruits and vegetables eaten at home. An apple pie eaten at home could be prepared from scratch or purchased ready-to-eat at a retail outlet. Unfortunately, dietary recalls do not ask how a food was prepared. We used the home-share statistics in figure 1 when predicting dietary improvements under a subsidy program. We first multiplied these at-home shares by recent total consumption—the sum of at-home and away-from-home consumption—to derive an estimate

Figure 1

Shares of fruits and vegetables eaten at home



Source: National Health and Nutrition Examination Survey, 1999–2002.

of how much fruits and vegetables individuals were eating at home. We then increased only this estimate according to our price elasticities.

To our knowledge, there is no empirical estimate of retail supply elasticities for fruits and vegetables. Consequently, we assumed that the increase in demand induced by a price subsidy could be met by increased supply at the same market price—a perfectly elastic supply. This assumption may have caused us to overstate how consumption would respond to price changes.

Finally, we note that all low-income households were assumed to be eligible for the price discount. The low-income population included households that are income eligible for the Supplemental Nutrition Assistance Program (SNAP). In fact, about 61 percent of those who were eligible received benefits in 2004 (Cunnyngham et al., 2007). A subsidy program that was linked to SNAP participation, therefore, would reach only a subset of eligible households.

Dietary Improvement for Low-Income Americans From a Price Discount

Predicted consumption under three levels of a price discount—5, 10, and 20 percent—were estimated using the two demand price elasticities reported by Park et al. (1996) and Huang and Lin (2000) for fruits and vegetables. These elasticities, together with actual and recommended consumption of fruits and vegetables for low-income households, are provided in table 5. Predicted levels of consumption, as well as actual and recommended consumption for fruits and vegetables, are further depicted in figure 2 for small and large elasticities. As expected, a price discount results in increased food consumption, and the increase in consumption was larger with the steeper price discount and larger elasticity.

A 10-percent price discount would have a modest, though statistically significant, impact on consumption. For example, at-home fruit consumption was predicted to increase from 0.72 cup to 0.74 cup for the smaller elasticity (-0.34) and to 0.77 cup for the larger elasticity (-0.65). Similarly, at-home vegetable consumption was predicted to increase from 1 cup to 1.03 cups for the smaller elasticity (-0.32) and to 1.07 cups for the larger elasticity (-0.70).

Table 5
Actual and recommended consumption of fruits and vegetables and their demand elasticities for the low-income households

Item	Recommended total	Actual consumption, 1999-2002			Elasticity	
		Total	Home share	Home	Small	Large
	- - -Cups - - -		*Percent*	*Cups*		
Total vegetables	2.48	1.43	0.70	1.00	-0.32	-0.70
Total fruits	1.74	0.96	0.75	0.72	-0.34	-0.65

Source: Economic Research Service calculations based on National Health and Nutrition Examination Survey data and the literature.

As noted earlier, these numbers were calculated using elasticity estimates and the at-home consumption level (table 5).

Under the hypothetical 10 percent price discount, we predicted total consumption, which includes away-from-home foods with a fixed price, would also rise modestly with increased home consumption. Total consumption for the smaller (larger) elasticity was predicted to be 0.98 (1.01) cup for fruits (increased from 0.96 cup) and 1.46 (1.50) cups for vegetables (increased from 1.43 cups).

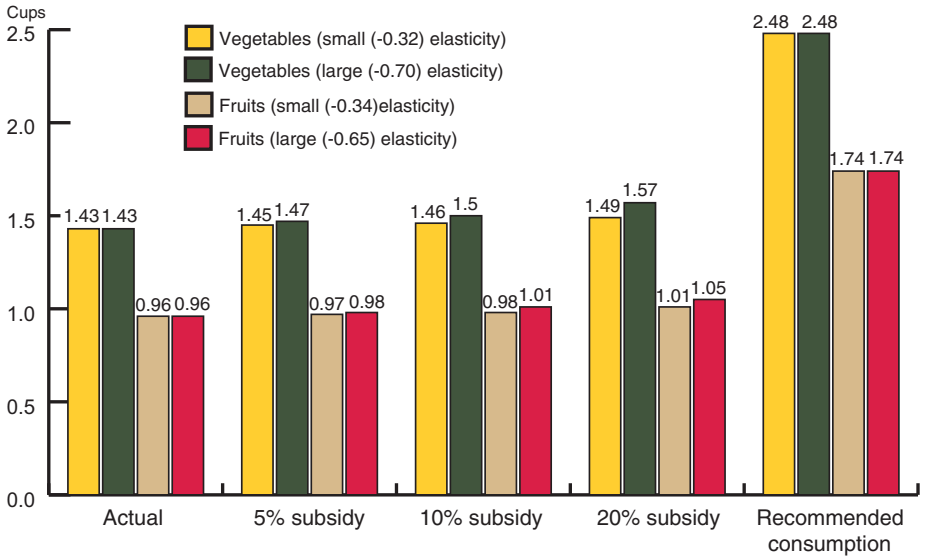
At the increased levels for total consumption, the diets of low-income Americans would be improved slightly relative to the recommendations, with fruit consumption for the smaller (larger) elasticity case at 56 (58) percent (increased from 55 percent) and vegetable consumption at 59 (60) percent (increased from 58 percent). In terms of the consumption gap, a 10-percent price discount for the larger elasticity case was predicted to narrow the gap by 6.4 percent for fruits (i.e., (1.01-0.96)/(1.74-0.96)) and 6.7 percent for vegetables.

The Cost of a Subsidy Program for Low-Income Americans

The subsidy outlay is an important consideration when evaluating policy options to subsidize food purchases. The direct financial cost of a price discount—not including the indirect costs, such as administrative costs for implementing the subsidy—is the product of the price discount and the amount purchased under the discounted price. We do not know the price paid (for fruits and vegetables) or the amounts purchased by low-income households. The Federal Government, however, does collect data on household

Figure 2

Fruit and vegetable consumption, by low-income households, by elasticity



Source: Economic Research Service calculations.

food expenditures. Food spending and demand price elasticity can be used to estimate the cost of a subsidy. The demand price elasticity can be expressed as:

$$\varepsilon = \frac{\Delta Q/Q}{\Delta P/P} \quad ,$$

where P and Q are the prediscount price and consumption level, and Δ represents the change. Assume an $\alpha\%$ price discount is implemented (i.e., $\alpha\% = \Delta P/P$), the total subsidy outlay (TC) can be expressed as:

$$TC = (\Delta P)(Q + \Delta Q) = PQ(\frac{\Delta P}{P} + \frac{\Delta P}{P}\frac{\Delta Q}{Q}) = PQ[\alpha\% + (\alpha\%)^2\,\varepsilon]$$

Thus, the total outlay can be calculated from the prediscount spending PQ and the elasticity ε for a price discount $\alpha\%$. From the above equation, we see that the total cost is the sum of the cost at the prediscount consumption level represented by $PQ(\alpha\%)$ and the cost of increased consumption represented by $PQ[(\alpha\%)^2\,\varepsilon]$.

The U.S. Department of Labor, Bureau of Labor Statistics (BLS) conducts an annual Consumer Expenditure Survey (Diary Survey, various years), which can be used to estimate household spending on fresh and processed fruits and vegetables for home consumption. Survey respondents also report their household income. We estimated spending on fresh and processed fruits and vegetables for home consumption by households, which were segmented into three income classes using Federal poverty guidelines. In 2004, households that were income-eligible for SNAP spent $3.91 billion on fruits and $3.71 billion on vegetables (table 6). These expenditure estimates excluded spending away from home, as well as mixtures containing the food group in question.

Table 6
Total annual U.S. expenditures on fruits and vegetables, by income level, 2004

Item	Total	Income level[1]		
		Low income	Middle income	High income
			$ billion	
Fruits	27.50	3.91	7.94	15.65
Fresh	17.41	2.45	4.96	10.00
Processed	10.09	1.46	2.98	5.65
Vegetables	24.27	3.71	6.64	13.92
Fresh	16.93	2.56	4.46	9.91
Processed	7.34	1.15	2.18	4.01

[1] The low-income group has income up to 130 percent of poverty level, the middle-income group has income 131-300 percent of poverty level, and the high-income group has income 300 percent or more of poverty level.

Source: Economic Research Service calculations based on the Consumer Expenditure Survey data.

With a 10-percent price discount on fruits and vegetables purchased by low-income households, we would expect an annual outlay of $303 million for fruits at the smaller elasticity and $312 million at the larger elasticity (7.8 and 8.0 percent of recent expenditure, respectively), and the annual outlay for vegetables would hit $268 million at the smaller elasticity and $279 million for the larger elasticity (7.2 and 7.5 percent of recent expenditure, respectively) (table 7). The total cost can be broken down into two components—the cost under prediscount consumption level and the cost associated with increased consumption. The cost under prediscount consumption level was predicted to be $293 million for fruits and $260 million for vegetables. The cost of increased consumption depends on which elasticity we used: for the small elasticity, the cost of additional consumption was predicted to be $10 million for fruits and $8 million for vegetables; for the large elasticity, the cost of additional consumption was predicted to be $19 million for both fruits and vegetables.

Table 7
Annual cost of 10-percent price discount for fruits and vegetables for low-income households

Item	Total cost		Cost under prediscount consumption	Cost associated with increased consumption	
	Small elasticity[1]	Large elasticity[1]		Small elasticity[1]	Large elasticity[1]
			$ million		
Fruits	303	312	293	10	19
Vegetables	268	279	260	8	19

[1] Small elasticity for fruits: -0.34.
Large elasticity for fruits: -0.65.
Small elasticity for vegetables: -0.32.
Large elasticity for vegetables: -0.70.

Source: Economic Research Service calculations based on the Consumer Expenditure Survey data.

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Appendix: Estimating Price Elasticities of Demand

Obtaining estimates of price elasticities for fruits and vegetables was key to our analysis. To obtain these estimates, we modeled the demand for fruits and vegetables using 2004 Nielsen Homescan Data, which collected both UPC and random weight purchases. We allowed the responses to price changes by low-income households and high-income households to be different. In particular, we defined our model of a household's purchases of fruits and vegetables as:

$$(1) \qquad Q_{it} = X_{it}\,\beta + D_i V_{it}\,\beta_L + (1 - D_i)V_{it}\,\beta_H + e_{it}$$

where Q_{it} is the purchase quantity by household i at time t. X_{it} is a vector of demographic and socio-economic variables. V_{it} is the unit value of fruit and vegetable products paid by household i at time t. D_i is a dummy variable, which equals 1 if household i's income is less than 130 percent of the Federal poverty level or equals 0 otherwise. βs are parameters to be estimated, where β_L is the price response by low-income households and β_H is the response by high-income households. From β_L and β_H, we calculate the own-price elasticities for both low-income and high-income households. e_{it} is an error term, which accounted for household heterogeneity effects. The unit value, V_{it}, is derived from the observed household purchase expenditure and quantity. V_{it} is endogenous and thought to capture the quality of the purchased food commodity (Deaton, 1987 and 1990; Cox and Wohlgenant, 1987; and Dong et al., 1998). Thus, in addition to the purchase equation, we also defined unit value as a function of a vector of demographic and socio-economic variables (Z_{it}):

$$(2) \qquad V_{it} = Z_{it}\,\alpha + \varepsilon_{it},$$

where α is parameter, and ε_{it} is an error term.

We used the predicted unit value from equation 2 in the estimation of equation 1. The elasticities obtained from the model are adjusted for quality as suggested by Deaton (1988).

Nielsen Homescan Panel Data provided information on households' purchases of fruit and vegetable products for at-home consumption. The purchase data included the date of purchases, total expenditures, food quantities, product descriptions, and more. Household characteristic variables such as income and household size were also provided. In this study, we estimated demand for all fruit and vegetable types. We aggregated purchases of all fruit or vegetable types in all forms, such as fresh, dried, and canned. We reformulated the data to a weekly basis and used the estimation procedure described by Dong and Kaiser (2008) to obtain model estimates.