Journal of Agricultural and Resource Economics 28(3):465–480

Do Income Constraints Inhibit Spending on Fruits and Vegetables Among Low-Income Households?

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This study assesses whether income constraints inhibit spending on fruits and vegetables among low-income households. If this is the case, then it is hypothesized that the distribution of expenditures on fruits and vegetables by low-income households should be stochastically dominated by the distribution of expenditures on these same food items by other households. Moreover, it must be the case that low-income households would increase their spending on fruits and vegetables in response to an increase in their income. Using household data from the 2000 Consumer Expenditure Survey, a test of stochastic dominance is performed. Censored quantile regressions are also estimated at selected points of the conditional expenditure distribution. Low-income households are found to spend less on fruits and vegetables than other households, but they are not responsive to changes in income.

Key words: censored least absolute deviations, consumption, fruits and vegetables, low-income households, nutrition, sample design, stochastic dominance

Introduction

In recent years, both public and private organizations have noted that typical Americans do not consume enough of most types of fruits and vegetables to meet the recommended dietary intake as outlined in the Federal Food Guide Pyramid. Kantor reports that, except for potatoes, American households need to increase their consumption of fruits and vegetables. Echoing Kantor's findings, the Produce for Better Health Foundation found only 38% of all individuals consume the recommended number of servings of vegetables, while only 23% consume the recommended number of servings of fruit.

Krebs-Smith et al. document that members of low-income households *on average* consume even smaller quantities of fruits and vegetables than members of other households. One explanation for this finding may be that low-income households cannot afford fruits and vegetables. Focus group studies of low-income consumers identify the cost of such food as an obstacle to fruit and vegetable consumption (Bradbard et al.; Shankar and Klassen). However, these same analyses also identify other obstacles, including the time required to prepare fruits and vegetables as compared with convenience foods, the need to provide food acceptable to children, taste preferences for other types of food, and too little information about how to purchase and prepare nutritious foods. (See Blaylock et al. for a survey of the many factors determining a household's food choices.)

The authors are researchers with the Economic Research Service, U.S. Department of Agriculture. We wish to thank Parke Wilde, Joanne Guthrie, Mark Denbaly, Nicole Ballenger, Angus Deaton, James Powell, and Stephen Howes for helpful comments. Any remaining errors and omissions are solely the responsibility of the authors. The views and opinions expressed in this paper do not necessarily reflect the views of the Economic Research Service.

Review coordinated by Gary D. Thompson.

The existing literature is not clear about why low-income households tend to consume less fruits and vegetables per person than their higher income counterparts. Only a few researchers have examined the income elasticity of demand for fruits and vegetables among households at different income levels. When studying low-income households, empirical evidence of a strong association between an increase in income and the demand for fruits and vegetables would support the argument that an inability to pay for fruits and vegetables is an important obstacle to improved diets. Evidence of no income effect would be more supportive of the notion that other issues, such as taste preferences or a lack of nutritional knowledge, are the primary deterrents to a more healthy diet.

Park et al. found the demand of low-income households for produce is more responsive to a marginal change in income than that of other households. Evidence presented by Raper, Wanzala, and Nayga suggests low-income and other households similarly increase their expenditures on fruits and vegetables with a marginal increase in total food expenditures. However, these findings contrast with implications drawn from research on the Food Stamp Program. Wilde, McNamara, and Ranney argue that food stamps are not associated with higher levels of fruit and vegetable consumption; rather, recipient households tend to consume more meats, added sugars, and total fats.

Discrepancies between the findings in the above studies may reflect the modeling procedures employed. Characterizing the subsistence bundle of low-income households was the primary goal set forth by Park et al., as well as by Raper, Wanzala, and Nayga. Thus, in order to show how this bundle depends upon the economic and demographic characteristics of a household, the researchers fit data to a linear expenditure system. However, this model requires restrictive assumptions about the nature of consumer demand. For instance, the linear expenditure system does not allow for complements or inferior goods. It also assumes constant marginal budget shares.

It is also possible that differences in data are responsible for discrepancies in past studies. Wilde, McNamara, and Ranney use data on quantities consumed, while the other studies examine expenditures. Expenditures and consumption are not perfectly correlated. Expenditures also depend upon the quality of goods, where goods are purchased, and whether goods are purchased "on sale" or with a coupon.[1] Thus, discrepancies in the existing literature could be reconciled by arguing that low-income households do not increase the quantity consumed with a marginal change in income, but they do consume higher quality fruits and vegetables. Still, this is only one possible explanation.

In this study, using traditional Engel curves and household expenditure survey data, the relationship between a household's income and its expenditures on fruits and vegetables is examined. While fruits and vegetables are defined to include the aggregate of both fresh and processed varieties, fresh and processed items are considered separately in some parts of the analysis. For instance, even if low-income households are found to spend less on the aggregate of fruits and vegetables than other households, it would remain to be determined whether this discrepancy existed for spending only on fresh fruits and fresh vegetables, or only for processed items, or both.

The goal of this study is based on the consideration of two questions. First: Do the "poor" in general spend significantly less money on fruits and vegetables than the non-poor? To answer this question, households in the data are classified as "poor" if their

[1] Similarly, fruits and vegetables may be purchased but then allowed to spoil or be consumed by others not in the household.

income equals 130% of the poverty line or less. This point of delineation was selected as households with higher income levels are not income-eligible for benefits under the Food Stamp Program.[2] A test is then conducted of whether the distribution of fruit and vegetable expenditures associated with the poor is stochastically dominated by the same expenditure distribution for the non-poor.

The second question posed is: Do poor households, conditional on relevant economic and demographic characteristics, tend to increase their expenditures on fruits and vegetables following an increase in their income? To test this hypothesis, censored quantile regressions are estimated at selected points on the conditional distribution of fruit and vegetable expenditures. Empirical evidence of a strong income effect would support the argument that the cost of fruits and vegetables is an important constraint to an improved diet among low-income households. Evidence of no income effect would be more supportive of the contention that other non-income factors are the primary deterrents to a more healthy diet.

Methodology

A comparison of mean expenditures would be the simplest way to determine whether poor households spend less than non-poor households on fruits and vegetables. However, such a comparison would also be incomplete. For instance, it is possible only a small percentage of the poor spend less than their higher income counterparts. In such a case, based only on a comparison of sample means, a researcher might conclude the two populations are statistically different. Yet, if the two expenditure distributions overlap, such a conclusion might not be justified. It may be useful to further account for potential differences in how expenditures are distributed for each type of household, such as the spread and skewness of these distributions.

In this study, a test of first-order stochastic dominance is conducted in order to compare the distribution of fruit and vegetable expenditures associated with the poor and the non-poor. Under first-order stochastic dominance, the cumulative density function (CDF) of one distribution lies everywhere below the CDF of the other distribution. Let X be per capita expenditure on fruits and vegetables, and let $F(X)$ be the CDF of X.

Consider two distributions of X: $F_{non\text{-}poor}(X)$ and $F_{poor}(X)$. If $F_{poor}(X) > F_{non\text{-}poor}(X)$ over all X, then the distribution of X described by $F_{non\text{-}poor}(X)$ first-order stochastically dominates the distribution described by $F_{poor}(X)$.[3] In this case, it can be said the distribution of expenditures by poor households always has more mass in the lower part of the CDF, and, as such, is "poorer" in fruit and vegetable expenditures than the same distribution for non-poor households. Tests of stochastic dominance have been applied to studies of finance and risk analysis (e.g., Hinson, Huh, and Lee) as well as to analyses of income and poverty (e.g., Bishop, Formby, and Zeager; Cowell; Davidson and Duclos; Howes 1993; Jolliffe).

[2] Other points of delineation would have been possible, such as 100% or 200% of the poverty line. However, using 130% of the poverty line allows for maximum comparability with the existing literature, such as Wilde, McNamara, and Ranney, which focuses on food stamp recipients. Households with incomes greater than 130% of the poverty line are not income-eligible for benefits under the Food Stamp Program. However, the reader should be aware that some households classified as "non-poor" in this study will have received some food stamps—because the receipt of food stamps can lift a household's total income over 130% of the poverty line. Alternatively, a household may have received food stamps over only a portion of the year, earning enough money to make it income-ineligible for benefits during other times of the year.

[3] Stochastic dominance can also be restricted in such a way that it need hold only over some range of X.

The test of stochastic dominance will determine whether one group of consumers spends less on fruits and vegetables than another group. However, this test does not explain the cause of any such discrepancy. In order to determine whether income or another factor is responsible for the observed difference in expenditures, if any, it is necessary to model how a household can be expected to adjust its expenditures on fruits and vegetables following an increase in income.

The next step of the study includes modeling expenditures by poor and non-poor households on fruits and vegetables conditional on these households' income, level of education, age profile, and other relevant characteristics. Before proceeding, it is important to note that prices do not explicitly enter these models. In lieu of prices, which are not available, the Engel model includes the household's region of residence and the season of the year when the survey was administered. For example, a household located in the Northeast in the winter is expected to encounter a different set of prices for fruits and vegetables than a household located in the West in the summer. After accounting for regional and seasonal differences, households are assumed to face similar prices.

In the regression model, observed differences in expenditures across households are likely due to differences in both the quality and quantity of fruits and vegetables purchased. Studies have shown that members of low-income households consume a smaller quantity of fruits and vegetables on average than their higher income counterparts (e.g., Krebs-Smith et al.). However, it is also possible these two types of households purchase differently priced fruits and vegetables. For example, a pound of asparagus may be more costly than a pound of bananas. Consequently, if a poor household eats relatively more bananas and a non-poor household eats relatively more asparagus, differences in expenditures may be greater than differences in consumption.

Some households did not spend any money on fruits and vegetables during the two-week survey period when data were collected. These data are then censored at zero and the economic model can be described as follows:

$$y_i = \begin{cases} \mathbf{x}_i\beta + e_i & \text{if } \mathbf{x}_i\beta + e_i > 0, \\ 0 & \text{if } \mathbf{x}_i\beta + e_i \leq 0, \end{cases} \tag{1}$$

where y_i is expenditures by household i, $\mathbf{x}_i$ is a vector of variables describing household i, e_i is an error term, and β is a vector of unknown parameters. Due to censoring, an ordinary least squares (OLS) regression of $\mathbf{Y}$ on $\mathbf{X}$ can result in biased parameter estimates. The zero-mean restriction placed on the residuals will not generally hold. A standard procedure to correct for zero censoring is to use the Tobit estimator. However, if the error term is not normally distributed and homoskedastic, Tobit estimates are themselves biased.

In the presence of nonnormal, heteroskedastic errors and censored dependent variables, Powell's censored least absolute deviations (CLAD) estimator is consistent for β in (1). An additional advantage of the CLAD, or any quantile estimator, is that it is more robust to outliers than least-squares estimators because the median regression is affected by whether predicted residuals fall above or below the median and not by the square of their distance from the mean.

Powell's CLAD estimator chooses the β that minimizes:

$$\sum_i |y_i - \max(0, \mathbf{x}_i\beta)|. \tag{2}$$

This estimator builds on the least absolute deviations (LAD) estimator, for which Koenker and Basset provide a proof of consistency and a derivation of its distribution. The consistency of the CLAD then rests on the fact that medians are preserved by monotone transformations of the data, and (2) is a monotone transformation of the LAD.

The algorithm used in this study for the CLAD estimator is Buchinsky's (1994) iterative linear programming algorithm. This algorithm first produces LAD estimates on the full sample, then deletes observations associated with negative predicted values, and reestimates the LAD on the trimmed sample. The iterative linear programming algorithm converges if there are no negative predicted values on two successive iterations. As shown by Buchinsky (1991), if the process converges, then a local minimum is obtained. Standard errors for CLAD parameter estimates are obtained through a design-matrix bootstrap procedure.[4]

A further advantage of the CLAD estimator is that the results of the median regression described by (2) can be compared with estimation results obtained by calculating regressions for other quantiles (e.g., see Deaton, pp. 83–84). This exercise can be interesting because the likelihood of a household underconsuming fruits and vegetables may vary at different points on the conditional expenditure distribution.[5] Recent applications of quantile regression to food demand include an analysis by Variyam, Blaylock, and Smallwood who show explanatory variables have differential impacts at different points along the conditional distribution of macronutrient intakes. Therefore, in this study, separate parameter estimates for the poor are obtained at the 25th, 50th, and 75th percentiles of the conditional expenditure distribution. If income is insignificant at all of these points, it can be inferred that the poor choose to allocate an additional dollar of income to goods other than fruits and vegetables. In addition, these estimates can then be compared to the corresponding estimated equations for non-poor households.

The question of how to derive marginal effects from CLAD parameter estimates has not been discussed in the literature. As observed from (1), the estimated change in y_i following a small change in $\mathbf{x}_i$ is β if household i has nonzero expenditures and continues to make some positive level of purchases. However, households with zero expenditures may respond differently. Unlike the case of the Tobit model, the literature does not provide a procedure for estimating an expected marginal response for the full sample from CLAD parameter estimates.

While further research on the subject is required, in this study, we interpret the coefficients in the median regression in a manner which is arguably more in the spirit of quantile regression.[6] Specifically, $\hat{p}$ is denoted as the percentage of households for whom $\mathbf{x}_i\hat{\beta} > 0$ is greater than zero. Then, if $\hat{p} > 0.5$, $\hat{\beta}$ is interpreted as the estimated "median response for the median consumer." Intuitively, given the regressors ($\mathbf{X}$), if a majority of consumers have positive medians, the median response is $\hat{\beta}$. Conversely, if $\hat{p} < 0.5$, the median response is assumed to be zero.

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[4] For a general discussion of the bootstrap, see Efron and Tibshirani. In a Monte Carlo study, Buchinsky (1995) demonstrates that the design-matrix bootstrap performs the best for approximating the sampling variance of the CLAD.

[5] Quantile regression explains a household's expenditures on fruits and vegetables conditional on its characteristics, such as household income and the age composition of its members. As usual, the difference between the fitted values and the observed levels of expenditure are the residuals. The distribution of these residuals then comprises the conditional expenditure distribution. As such, the reader should be cognizant that a household's position on the conditional expenditure distribution does not necessarily correspond to its position on the unconditional expenditure distribution.

[6] The authors thank Dr. James Powell for suggesting (through personal correspondence) this interpretation of CLAD estimation results. Notably, this interpretation applies only to the median regression and may not necessarily be applied to regressions at other quantiles.

Data

This study relies on data from the diary portion of the 2000 Consumer Expenditure Survey (CES). The CES is administered annually by the U.S. Department of Labor, Bureau of Labor Statistics (BLS) and is designed to measure expenditure, income, and relevant demographic characteristics for the total noninstitutionalized U.S. population. In the diary section of the survey, households report their expenditures on food items for two weeks. These data can then be matched with information on the household such as its annual income, level of education, age of members, the number of members, region of residence, and the time of year when the survey was administered.

The 2000 CES includes 5,179 households after removing households providing incomplete data on their income, households not providing data for both weeks of the diary, and households failing to provide complete data on other characteristics of interest, such as the age of members of the household. Demographic data on each household remaining in the sample can then be linked with information in the CES on the same household's spending for fruits and vegetables at home. Notably, these spending data do not account for spending for fruits and vegetables purchased as part of a meal or snack in a food-service facility. Hence, these data may underestimate total fruit and vegetable spending.

A household in this study is classified as being poor if the household's income equals 130% of the poverty line or less. For instance, in fiscal year 2000, the poverty line was $17,463 per year for a family of four people with two related children under 18 years of age. Thus, by this definition, a household of the same composition with an annual income of up to $22,701.90 is classified as poor. This definition of low income is used because, as noted earlier, households with higher incomes are not income-eligible for the Food Stamp Program.

Table 1 presents mean expenditures on fruits and vegetables by poor and non-poor households in the sample. The means are calculated by averaging the household's weekly spending on fruits and vegetables over the two-week survey period, and then dividing this measure of spending by the number of members in the household. Table 1 also contains per capita weekly expenditures on four categories of fruits and vegetables: fresh fruits, fresh vegetables, processed fruits, and processed vegetables. The means in table 1 have been weighted and the standard errors have been corrected for sample-design effects.[7]

Stochastic Dominance Results

A test of stochastic dominance is used to compare per capita weekly spending on fruits and vegetables by the poor and the non-poor. This test is conducted over the range of per capita expenditures from zero to $20, which contains 98.3% of all observations in the sample. The approach in this study is similar to that of Raper, Wanzala, and Nayga, who remove the upper 1% of each expenditure and income category "to circumvent problems associated with data outliers" (p. 983). Outliers can create problems in both hypothesis testing and in interpreting estimation results. For instance, one non-poor household spent an average of $119.52 per capita each week over the survey period,

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[7] As recommended by the BLS, the design-corrected standard errors have been estimated with the use of the 44 CES replicate weights following the method of balanced repeated replication (Kish and Frankel).

Table 1. Means and Standard Errors for Fruit and Vegetable Expenditures by Poor and Non-Poor Households

		Mean / (Std. Error)	
Expenditure Description		Poor	Non-Poor
All Fruits and Vegetables:		3.588 (0.151)	5.021 (0.105)
Fresh Items:	▸ Fruits	1.090 (0.057)	1.608 (0.043)
	▸ Vegetables	1.085 (0.052)	1.543 (0.040)
Processed Items:	▸ Fruits	0.830 (0.058)	1.086 (0.026)
	▸ Vegetables	0.583 (0.032)	0.783 (0.022)
Sample Size		991	4,188

Notes: Expenditures are measured as dollars per capita per week. Standard errors (in parentheses) are corrected for sample-design effects using the replicate weights and following the method of balanced repeated replication (Kish and Frankel).

which is the maximum of all observations. However, this spending is more likely to reflect a special event, such as purchasing fruits and vegetables for a wedding reception, than to be representative of this household's normal pattern of eating.

Figure 1 plots the CDF for both poor and non-poor households. As seen from this graph, the CDF for poor households lies everywhere above the CDF of the non-poor. For example, 19% of the poor spend zero dollars on fruits and vegetables versus only 9% of the non-poor. Importantly, this gap continues to hold at all levels of spending. The graph reveals that 56% of poor households spend $3 or less per capita compared with only 41% of non-poor households.

The next question is whether the gap between the two CDFs is everywhere statistically different from zero. In accordance with Howes (1993, 1994), t-statistics are calculated over a grid of points. The significance of these test statistics indicates whether the observed difference between the two CDFs is significant. Indeed, it is found that the t-statistics are everywhere statistically significant over the range of the distribution under study. Thus, spending on fruits and vegetables by poor households is "dominated" by the corresponding spending patterns of non-poor households, which is consistent with past studies. However (as far as the authors are aware), past studies based their conclusions on simple tests of sample means and proportions, not on first-order dominance.

It is interesting to further consider whether the above empirical results hold for fresh and processed items evaluated separately. For instance, even though the poor spend less on the aggregate of fruits and vegetables compared to non-poor households, it remains to be determined whether this discrepancy might exist for only fresh fruits and vegetables, for just processed items, or both categories. For example, it might be the case that the poor are encouraged to concentrate their expenditures on processed fruit and vegetables, if fresh fruits and vegetables are relatively more expensive per serving or require more preparation time.

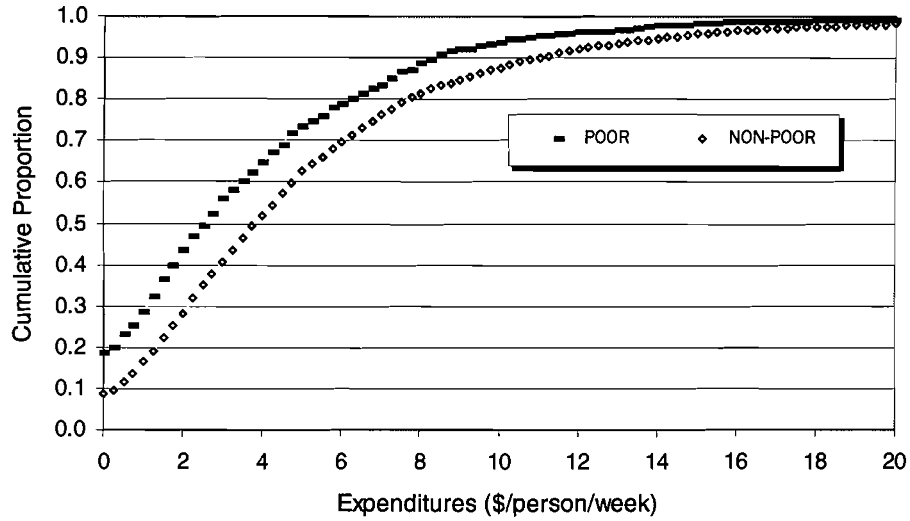

Figure 1. Poor and non-poor, all fruit and vegetable expenditures: Stochastic dominance analysis

Spending on fresh fruits and vegetables by the non-poor also stochastically dominates the spending patterns of the poor. For instance, 24% of the poor spend zero dollars on fresh fruits and vegetables versus only 13% of the non-poor. This gap continues to hold at higher levels of expenditure. Seventy-three percent of poor households spend $3 or less on fresh fruits and vegetables as compared with 62% of the non-poor. The distance between the two CDFs remains statistically significant from zero over the range of $0 to $19, which comprises over 99% of all households in the data.

Expenditures by the non-poor on processed fruits and vegetables also stochastically dominate the expenditures of the poor. However, in this case, stochastic dominance held only over 97.4% of the distribution, which is not as strong a result as obtained when considering only expenditures on fresh fruits and vegetables. To be sure, the CDF associated with spending by poor households again lies everywhere above the same CDF for non-poor households—i.e., 30% of the poor spend zero dollars on processed fruits and vegetables versus only 19% of the non-poor. Similarly, the gap remains significant at $7. About 98% of poor households spend this much or less on processed fruits and vegetables as compared with 97% of the non-poor. However, the distance between the two CDFs is not statistically significant at levels of expenditure greater than $7.

Censored Regression Results

The stochastic dominance tests demonstrate that poor households spend significantly less on fruits and vegetables, especially fresh varieties, than non-poor households. It is now appropriate to ask why this discrepancy exists. Thus, the next step of this analysis involves estimating Engel curves through quantile regressions of per capita weekly expenditures on income and other relevant variables. The definitions, weighted means, and corrected standard errors for the explanatory variables are given in table 2.

The explanatory variable of primary interest is a household's weekly per capita income (*INCOME*). Notably, among the many definitions of income provided in the CES,

Table 2. Definitions, Means, and Standard Errors of Explanatory Variables

		Mean / (Std. Error)	
Variable	Definition	Poor	Non-Poor
INCOME	Annual income (pre-tax hundreds of dollars/person/week)	1.017 (0.018)	5.073 (0.115)
FOODSTAMP	Food Stamp benefits (hundreds of dollars/person/week)	0.019 (0.002)	
HOUSEHOLD SIZE	Inverse of number of people residing in household	0.637 (0.015)	0.530 (0.005)
BLACK	= 1 if household is Black, 0 otherwise	0.184 (0.012)	0.103 (0.004)
HIGH SCHOOL	= 1 if 12 years of schooling or GED, 0 otherwise	0.303 (0.017)	0.277 (0.009)
SOME COLLEGE	= 1 if 1–3 years of college completed, 0 otherwise	0.280 (0.026)	0.294 (0.009)
COLLEGE	= 1 if 4 years or more of college completed, 0 otherwise	0.083 (0.009)	0.315 (0.009)
PRO75	Proportion of household members age 75 or older	0.157 (0.013)	0.074 (0.003)
PRO65–74	Proportion of household members age 65–74	0.112 (0.010)	0.088 (0.003)
PRO45–64	Proportion of household members age 45–64	0.170 (0.010)	0.275 (0.004)
PRO30–44	Proportion of household members age 30–44	0.140 (0.007)	0.250 (0.005)
PRO20–29	Proportion of household members age 20–29	0.185 (0.022)	0.135 (0.005)
PRO15–19	Proportion of household members age 15–19	0.081 (0.010)	0.048 (0.002)
PRO10–14	Proportion of household members age 10–14	0.047 (0.005)	0.043 (0.002)
PRO5–9	Proportion of household members age 5–9	0.056 (0.005)	0.043 (0.002)
PRO5	Proportion of household members under age 5	0.042 (0.005)	0.035 (0.002)
WINTER	= 1 if household was surveyed in Winter, 0 otherwise	0.280 (0.014)	0.254 (0.006)
SPRING	= 1 if household was surveyed in Spring, 0 otherwise	0.267 (0.014)	0.262 (0.004)
SUMMER	= 1 if household was surveyed in Summer, 0 otherwise	0.251 (0.014)	0.250 (0.005)
MIDWEST	= 1 if household resides in the Midwest, 0 otherwise	0.181 (0.018)	0.253 (0.009)
SOUTH	= 1 if household resides in the South, 0 otherwise	0.423 (0.025)	0.337 (0.013)
WEST	= 1 if household resides in the West, 0 otherwise	0.233 (0.036)	0.214 (0.012)
Sample Size		991	4,188

Note: Standard errors (in parentheses) are corrected for sample-design effects using the replicate weights and following the method of balanced repeated replication (Kish and Frankel).

this study uses total, annual pre-tax income, which is a relatively comprehensive definition including sources other than wages and salary income, such as the value of Food Stamp Program receipts and income from Social Security. Past studies show fruits and vegetables to be a normal good (Blisard, Variyam, and Cromartie; Raper, Wanzala, and Nayga; Park et al.; Nayga; Blisard and Blaylock). Consequently, a household's expenditures on fruits and vegetables would be expected to be increasing in *INCOME*. Apparently, however, no previous studies have examined the impact of a change in income on fruits and vegetable expenditures at different points along the conditional expenditure distribution.

In order to allow for a more general test of the relationship between a household's income and its expenditures on fruits and vegetables, the model was also estimated with the square of *INCOME* included among the regressors ($INCOME^2$). If negative and statistically significant, this variable would allow expenditures on fruits and vegetables to increase at a decreasing rate in income. Banks, Blundell, and Lewbel discuss the importance of allowing for a quadratic Engel curve. Such a specification has been further shown to provide a good fit to data in empirical analyses of household expenditures on disaggregated food commodities (e.g., Blisard, Variyam, and Cromartie).

Each survey respondent's level of education is also included in the model. Past studies have found better-educated people tend to spend more on fruits and vegetables. For example, this pattern may be due to a superior knowledge of diet and health issues (e.g., Blisard, Variyam, and Cromartie). Therefore, in this study, binary variables are included to account for whether the survey respondent has a college education or a more advanced degree (*COLLEGE*), some college education (*SOME COLLEGE*), a high school degree (*HIGH SCHOOL*), or no high school degree (*NONE*). To prevent perfect collinearity, *NONE* was omitted from the model.

The age profile of a household may also be important. Past studies have found households with older members spend more money on fruits and vegetables than younger households. This difference may be due to differences in the palate and health requirements of people at different stages of their life (see, e.g., Variyam, Blaylock, and Smallwood). Thus, variables were created to account for the proportion of members in a household falling between certain age levels. For example, the variable *PRO75* measures the proportion of household members who are aged 75 or older. By contrast, *PRO65–74* is the proportion of household members between 65 and 74 years of age. For purposes of model estimation, *PRO45–64* is the omitted category.

The inverse of a household's size is included in the model to control for variations in the number of members across households, *HOUSEHOLD SIZE*. The inverse of the size variable captures the effects of economies of size in purchasing and preparing food. Because the inverse is decreasing in the number of members in the household, a positive coefficient on this variable indicates positive economies of size. In other words, a larger household tends to spend less per person than smaller households.

Finally, an indicator variable was included to account for the race of the survey respondent (simply defined as *BLACK* or *NON-BLACK*), as well as the aforementioned variables to control for a household's region of residence and the season of the year in which the survey was conducted (table 2).

The quantile regressions were estimated with the Stata software package, employing a variant of the CLAD procedure (Jolliffe, Krushelnytskyy, and Semykina), which was adapted to incorporate sampling weights. Thus, the coefficients in table 3 are the weighted CLAD coefficients at the 25th, 50th, and 75th percentiles of the poor and non-poor conditional expenditure distributions. Each regression has a pseudo-R^2 of between approximately 0.02 and 0.10.

As observed from table 3, *INCOME* is insignificant at all points examined on the conditional distribution of fruit and vegetable expenditures associated with the poor. For example, the estimated coefficient on *INCOME* in the median regression is not statistically different than zero. It follows that the median response of a poor household at the median of the conditional expenditure distribution is to maintain the same level of expenditures on fruits and vegetables following a small change in *INCOME*.[8] As a further check, these models were reestimated including $INCOME^2$, with *INCOME* and all other explanatory variables previously considered. As argued earlier, the inclusion of $INCOME^2$ allows expenditures to increase at a decreasing rate with income, if the quadratic term is negative and statistically significant. However, in this case, the sign and significance of the linear term were never affected by the inclusion or exclusion of the quadratic term. Moreover, the quadratic term was always insignificant.

Unlike the case of poor households, *INCOME* is found to be statistically significant at the 25th, 50th, and 75th quantiles of the conditional expenditure distribution of the non-poor. For example, following a unit increase in *INCOME*, the median response of a non-poor household at the median is to increase its spending on fruits and vegetables by $0.09 per capita, per week. Notably, these models were also estimated with and without a quadratic term for income. The sign and significance of the linear term were again unaffected by the inclusion or exclusion of the quadratic term. Moreover, the quadratic term was always insignificant.

COLLEGE is positive and statistically significant in the median regressions for both poor and non-poor households. From table 3, if the household's respondent obtains a college education, the median response of a household at the median of the conditional expenditure distribution associated with the poor would be to increase spending on fruits and vegetables by about $1.57. This finding is consistent with the argument that education is correlated with an awareness of the importance of healthy eating.

Age profile is also a significant determinant of how much a household spends per capita on fruits and vegetables at one or more points on the conditional expenditure distribution of both the poor and other households. As reported in table 3, *PRO20–29* and *PRO15–19* are negative in all regressions and tend to be statistically significant as well. This result corroborates the notion that younger people demonstrate a preference for foods other than fruits and vegetables. However, as a person ages, health requirements may change and, in turn, the individual may purchase more fruits and vegetables.

Finally, the robustness of the above results was tested by separately examining the effect of income on spending by the poor for fresh and processed fruits and vegetables. Separate quantile regressions were estimated for both categories using the same explanatory variables. Table 4 reports the coefficients for this test at the median.[9] *INCOME* proved to be insignificant in both cases. Thus, for poor households, the above stated results for spending on all types of fruits and vegetables also hold for both fresh and processed categories in isolation.

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[8] Following the suggestion of Dr. James Powell, such an interpretation is appropriate, as $\hat{y}_i = \mathbf{x}_i\hat{\beta} > 0$ for a majority of households, i.e., if $\hat{p} > 0.5$. In this study, $\hat{p} = 0.97$ in the median regression for poor households. Similarly, $\hat{p} = 1$ for the same regression for the non-poor.

[9] Coefficient estimates for the 25th and 75th percentiles are available from the authors upon request.

Table 3. Censored Quantile Regression Analysis of All Fruit and Vegetable Expenditures by Poor and Non-Poor Households

	Poor			Non-Poor		
Variable	25th	50th	75th	25th	50th	75th
Constant	1.886*	3.654*	4.806*	3.247*	4.317*	6.677*
	(0.739)	(0.729)	(0.918)	(0.300)	(0.416)	(0.623)
INCOME	0.104	0.261	0.350	0.056*	0.090*	0.096*
	(0.372)	(0.390)	(0.440)	(0.027)	(0.025)	(0.046)
HOUSEHOLD SIZE	-0.651	-0.637	0.942	-1.703*	-0.159	2.682*
	(0.758)	(0.763)	(0.857)	(0.309)	(0.449)	(0.741)
BLACK	-0.272	-0.295	-0.374	0.116	-0.100	0.012
	(0.318)	(0.376)	(0.500)	(0.178)	(0.261)	(0.346)
HIGH SCHOOL	0.077	0.186	-0.390	0.207	0.568*	0.441
	(0.314)	(0.329)	(0.438)	(0.171)	(0.221)	(0.368)
SOME COLLEGE	0.279	-0.199	-0.320	0.306	0.716*	0.788
	(0.404)	(0.380)	(0.553)	(0.171)	(0.217)	(0.384)
COLLEGE	0.875	1.568*	1.400	0.873*	1.426*	1.721*
	(0.559)	(0.717)	(0.800)	(0.197)	(0.232)	(0.395)
PRO75	0.910	1.544	2.213*	-0.136	0.075	-0.208
	(0.658)	(0.787)	(0.950)	(0.355)	(0.401	(0.793)
PRO65–74	0.757	1.725	2.592*	0.595	0.859*	0.050
	(0.780)	(0.930)	(0.857)	(0.425)	(0.410)	(0.789)
PRO30–44	-0.968	-0.742	0.597	-1.326*	-1.366*	-2.338*
	(0.768)	(0.838)	(0.966)	(0.250)	(0.312)	(0.414)
PRO20–29	-1.114	-2.069*	-1.747*	-1.853*	-2.819*	-3.828*
	(0.830)	(0.680)	(0.812)	(0.204)	(0.357)	(0.573)
PRO15–19	-0.670	-1.922*	-2.427	-2.033*	-3.300*	-4.456*
	(0.993)	(0.787)	(1.252)	(0.410)	(0.597)	(0.822)
PRO10–14	0.542	-0.856	-0.770	-1.904*	-2.021*	-3.685*
	(1.024)	(0.938)	(1.223)	(0.499)	(0.596)	(0.851)
PRO5–9	-0.408	-0.967	-1.140	-1.928*	-2.858*	-4.664*
	(1.072)	(1.177)	(1.701)	(0.377)	(0.514)	(0.999)
PRO5	0.020	-0.169	1.665	-1.619*	-2.504*	-4.251*
	(1.026)	(1.016)	(1.630)	(0.488)	(0.708)	(0.903)
WINTER	0.094	0.571	-0.076	0.055	0.028	-0.036
	(0.349)	(0.450)	(0.507)	(0.159)	(0.184)	(0.322)
SPRING	-0.242	0.199	-0.213	0.161	0.273	0.590
	(0.399)	(0.465)	(0.547)	(0.163)	(0.196)	(0.341)
SUMMER	0.113	0.281	-0.374	0.063	0.113	0.249
	(0.372)	(0.467)	(0.599)	(0.169)	(0.203)	(0.392)
MIDWEST	-0.433	-0.690	-0.356	-0.686*	-0.838*	-1.532*
	(0.460)	(0.532)	(0.710)	(0.170)	(0.203)	(0.349)
SOUTH	-0.670	-1.322*	-0.956	-0.675*	-0.843*	-1.178*
	(0.395)	(0.444)	(0.597)	(0.176)	(0.210)	(0.361)
WEST	-0.490	-1.012*	-0.472	-0.218	-0.431*	-0.703
	(0.431)	(0.452)	(0.675)	(0.169)	(0.219)	(0.381)
Pseudo-R^2	0.024	0.066	0.102	0.040	0.061	0.095

Notes: An asterisk (*) denotes statistical significance at the 5% level. Standard errors (in parentheses) are bootstrap estimates based on 500 replications of the design matrix.

Table 4. Analysis of Expenditures by Poor Households on Fresh and Processed Fruits and Vegetables, Median Regression

	Fruits and Vegetables			Fruits and Vegetables	
Variable	Processed	Fresh	Variable	Processed	Fresh
Constant	1.061*	2.206*	*PRO15–19*	-0.583*	-1.195*
	(0.342)	(0.564)		(0.380)	(0.525)
INCOME	0.173	0.097	*PRO10–14*	0.191	-0.260
	(0.184)	(0.227)		(0.434)	(0.695)
HOUSEHOLD SIZE	-0.493	-0.619	*PRO5–9*	0.258	-0.374
	(0.328)	(0.476)		(0.437)	(0.840)
BLACK	0.196	-0.207	*PRO5*	-0.055	-0.111
	(0.203)	(0.276)		(0.492)	(0.789)
HIGH SCHOOL	0.245	-0.049	*WINTER*	-0.159	0.189
	(0.160)	(0.248)		(0.184)	(0.318)
SOME COLLEGE	0.186	-0.051	*SPRING*	-0.173	0.046
	(0.203)	(0.273)		(0.175)	(0.305)
COLLEGE	0.513*	0.744	*SUMMER*	-0.002	0.183
	(0.240)	(0.403)		(0.165)	(0.290)
PRO75	0.580	0.820	*MIDWEST*	-0.114	-0.598
	(0.383)	(0.508)		(0.232)	(0.347)
PRO65–74	0.604	1.129	*SOUTH*	-0.207	-0.814*
	(0.394)	(0.730)		(0.198)	(0.357)
PRO30–44	-0.172	-0.518	*WEST*	-0.306	-0.461
	(0.323)	(0.513)		(0.202)	(0.338)
PRO20–29	-0.587	-0.986*			
	(0.319)	(0.406)	Pseudo-R^2	0.031	0.050

Notes: An asterisk (*) denotes statistical significance at the 5% level. Standard errors (in parentheses) are bootstrap estimates based on 500 replications of the design matrix.

The results reported above appear to agree with those of Wilde, McNamara, and Ranney. Because fruit and vegetable expenditures of the poor are not income responsive at major points on the conditional expenditure distribution, it is unlikely the poor would be responsive to an increase in their food stamp allotment. Studies have shown cash and food stamps are imperfect substitutes (e.g., Breunig et al.; Wilde and Ranney). Suppose, for example, a poor household without food stamps spends $20 per week per person on food. Now, further suppose the household is extended benefits under the Food Stamp Program—say the equivalent of $5 per person per week. Consider how the household might adjust its behavior. Generally, the household will not increase its spending on food to $25 per person per week. It will substitute some of the cash previously committed to food for purchasing more non-food goods.

As a check of whether food stamps are associated with increased expenditures on fruits and vegetables, alternative quantile regressions were estimated, and results are reported in table 5. These regressions include the value of the household's per capita weekly food stamp receipts (*FOODSTAMP*) as a separate explanatory variable. This variable is defined for only poor households, and only these households were included in these regressions. Moreover, because *INCOME* in the prior regressions included the value of food stamp receipts, this variable must be revised by subtracting *FOODSTAMP* from it. The revised income variable is denoted as *INCOME'*. Similar to the effects

Table 5. Analysis of Impact of Food Stamps on Spending on All Fruits and Vegetables, Poor Households

Variable	Quantile 25th	50th	75th	Variable	Quantile 25th	50th	75th
Constant	2.146*	3.737*	4.820*	*PRO15–19*	-1.011	-1.861*	-2.427
	(0.787)	(0.712)	(0.898)		(0.918)	(0.803)	(1.274)
INCOME'	0.075	0.288	0.348	*PRO10–14*	0.375	-0.950	-0.795
	(0.352)	(0.384)	(0.445)		(0.940)	(1.023)	(1.206)
FOODSTAMP	-0.008	-0.002	-0.014	*PRO5–9*	-0.915	-0.954	-1.195
	(0.027)	(0.024)	(0.036)		(1.198)	(1.215)	(1.697)
HOUSEHOLD SIZE	-0.949	-0.709	0.942	*PRO5*	0.342	0.092	1.523
	(0.760)	(0.791)	(0.842)		(1.242)	(1.030)	(1.666)
BLACK	-0.325	-0.284	-0.379	*WINTER*	0.092	0.640	-0.086
	(0.343)	(0.373)	(0.507)		(0.364)	(0.415)	(0.515)
HIGH SCHOOL	-0.032	0.121	-0.406	*SPRING*	-0.288	0.307	-0.207
	(0.322)	(0.340)	(0.439)		(0.388)	(0.453)	(0.547)
SOME COLLEGE	0.076	-0.186	-0.329	*SUMMER*	-0.012	0.254	-0.374
	(0.367)	(0.421)	(0.561)		(0.360)	(0.453)	(0.583)
COLLEGE	0.438	1.625*	1.371	*MIDWEST*	-0.152	-0.773	-0.341
	(0.515)	(0.702)	(0.780)		(0.494)	(0.540)	(0.702)
PRO75	0.909	1.457*	2.205*	*SOUTH*	-0.514	-1.351*	-0.960
	(0.681)	(0.788)	(0.959)		(0.408)	(0.472)	(0.580)
PRO65–74	0.720	1.709*	2.575*	*WEST*	-0.577	-1.006*	-0.454
	(0.776)	(0.864)	(0.870)		(0.441)	(0.485)	(0.664)
PRO30–44	-0.639	-0.900	0.628				
	(0.758)	(0.758)	(0.958)				
PRO20–29	-0.779	-2.290*	-1.715*				
	(0.778)	(0.715)	(0.830)	Pseudo-R^2	0.025	0.068	0.102

Notes: An asterisk (*) denotes statistical significance at the 5% level. Standard errors (in parentheses) are bootstrap estimates based on 500 replications of the design matrix. Among the 991 poor households in the sample, 147 received Food Stamp Program benefits.

reported by Wilde, McNamara, and Ranney, our results confirm food stamps are not associated with increased fruit and vegetable expenditures by poor households.

Conclusions and Policy Implications

In this study, poor households are found to spend less on fruits and vegetables than other households. However, an increase in income will not likely induce the poor to spend more on fruits and vegetables; rather, tastes and preferences, time constraints, or other factors may be the primary factors affecting their fruit and vegetable expenditures.

A second important result of this study concerns the behavior of non-poor households. Such households can be expected to increase their spending on fruits and vegetables in response to an increase in income. Clearly, among non-poor households, fruits and vegetables are normal goods.

Jointly, based on the findings associated with the behavior of both the poor and the non-poor, it can be concluded that the relationship between fruits and vegetables expenditures and income is consistent with a hierarchic representation of demand (e.g., see Jackson). Poor households appear to consume only a subsistence bundle of goods.

However, as their incomes increase, these households introduce new goods into their consumption bundle. Goods providing greater utility relative to their total cost will enter this bundle at lower levels of income than other goods yielding less utility relative to their total cost. Finally, the implication is that, in the neighborhood of income levels used to define a "poor" household in this study, most households apparently perceive other goods to be more desirable additions to their consumption bundle than fruits and vegetables.

In conclusion, the primary goal of this study was to assess whether income constraints inhibit the ability of the poor to purchase fruits and vegetables. The answer to this question is complex. On the one hand, results indicate poor households will not increase their fruit and vegetable expenditures in response to a small increase in income. In this sense, they are not constrained by their low income; rather, other factors cause poor households to not spend more on fruits and vegetables. On the other hand, given a transfer of wealth sufficient to take the poor out of poverty, it could be speculated that some of the current poor would choose to spend more on fruits and vegetables. The poor are income constrained in this latter sense.

[*Received January 2003; final revision received August 2003.*]

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