Estimating the Relationship between Education and Food Purchases among Food Insecure Households

John J Hogan
Master Student, Department of Agricultural and Resource Economics
University of Connecticut

Joshua P Berning
Assistant Professor, Department of Agricultural and Resource Economics
University of Connecticut

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Abstract:

As food insecurity and obesity become more severe, researchers and policy makers have increased their efforts to understand the causes of these problems. The purpose of this paper is to examine what effect education has on household expenditure for healthful foods, especially among the food insecure. Using the 2009 Consumer Expenditure Survey, we estimate a two step model that addresses endogenous selection into different levels of education. We find that investments made in education can increase expenditure on fresh fruits and vegetables among food insecure households. Therefore policies that increase educational programs in conjunction with food assistance programs could reduce both food insecurity and obesity levels.

I. Introduction:

Two prevailing problems seen today are the increasing number of food insecure and obese households. These problems have received substantial attention due to their significant increase in the United States. In 2007, roughly 11% of U.S. households were considered food insecure (Coleman-Jensen et al. 2011), while around 34 percent of the U.S. population was obese (Ogden et al. 2007). Since 2007, the percentage of food insecure households in the U.S. has gradually risen. In 2010, approximately 14.5 percent of households or 17.2 million Americans experienced some form of food insecurity (Coleman-Jensen et al. 2011). During this period, obesity levels remained high at 34 percent.

The consequences of food insecurity and obesity are substantial. Increases in food insecurity require additional federal and state tax dollars to fund food assistance programs while increases in obesity can lead to illnesses such as heart disease and diabetes which are associated with significant future health costs (Rowe et al. 2010; Finkelstein 2008). Though food insecurity and obesity appear to be separate issues, several studies examine their connection (Bhattacharya et al 2004; Dinour et al 2007). These studies conclude that limited income constrains the budget of food insecure households and incentivizes the purchase of inexpensive, unhealthful foods increasing the risk of obesity (Basiotis & Lino 2002; Drewnowski & Specter 2004; Drewnowski 2009; Trung & Sturm 2005; Kim & Leigh 2010). However, limited income may not be the only reason food insecure households make unhealthful food choices. Recent data suggests that 59.8 percent of households living below the poverty index were food secure throughout 2010 (Coleman-Jensen et al. 2011). This suggests that additional causes, beside limited income, may explain why food insecure households make unhealthful food choices.

A possible explanation is that food insecure households make unhealthful food choices because they do not efficiently invest in human capital. As a result of this inefficient investment, food insecure households are unable to allocate their resources efficiently. If food insecure households fail to make investments in education, they may allocate their limited income towards unhealthful foods (Grossman 1972; Grossman 2005). A lack of education reduces the ability of food insecure households to recognize the full costs involved with making an unhealthful food choice. By making unhealthful food choices, food insecure households increase their likelihood of obesity and future health costs (Gundgaard 2003; Finkelstein et al 2003). If education can improve the ability of a food insecure household to conceptualize the costs involved with unhealthful food choices, then investments in education can improve the ability of food insecure households to make healthful food choices and allocate income efficiently.

The goal of this paper is to examine if investments made in education results in more healthful food choices among households. On a basic level, increases in education can allow households to process information more efficiently, recognizing potential costs involved with certain food choices. In addition, education is potentially a proxy for nutritional knowledge of a household. We examine whether increases in educational attainment by the head of household result in increased expenditure on fresh fruits and vegetables. Fresh fruits and vegetables are used because these foods are associated with lower levels of obesity and illness that contribute to increased future costs (Gundgaard 2003). These food categories are consistently consumed below dietary recommendations proposed by the U.S. Food and Drug Administration (Dong and Lin 2009).

The data used for this study comes from the 2009 Consumer Expenditure Survey conducted by the Bureau of Labor Statistics. We estimate a two stage model as proposed by

Garen (1984). In the first stage we estimate an ordered probit to determine the effect of observable characteristics on the latent variable education. We consider education as a latent variable because each level of education may be different depending on the institution where the degree was achieved and subject matter studied for the degree. In the second stage, we incorporate the generalized residuals recovered from the first step as an additional regressor and as an interaction term with education in our linear model. This estimation approach controls for selection bias due to unobservable characteristics correlated with our dependent variable and independent variable, education.

We focus on two samples within our data set, all households and food insecure households. For all households, we find that an increase in education results in a 22 cent increase in per capita household expenditure on fresh fruits and vegetables per week. Additionally we find that for food insecure households, an increase in education results in a 1 dollar and 43 cent increase in per capita household expenditure on fresh fruit and vegetables per week. These relationships suggest that education plays an important role in making healthful food choices. This supports our hypothesis, that investments made in education can allow households to efficiently allocate income towards healthful food. Our findings could have several policy implications. If policies designed to increase educational programs are coupled with food assistance programs, food insecurity and obesity may decline as a result of more healthful food purchases.

This paper proceeds as follows: Section II will review relevant literature associated with food insecurity and human capital models. Section III will describe the data and Section IV will describe the empirical methods used for estimation of our model. Section V will discuss the results and Section VI will conclude the paper as well as discuss future research opportunities and policy implications.

II. Literature Review

Food insecurity and obesity have been two areas of extensive research in scientific and economic literature because of their growing presence within society. However no specific study has addressed the potential link between investments made in education and the efficient allocation of resources towards healthful foods. To motivate and support our research we review the concept of food insecurity, its possible connection with obesity, and how investments made in human capital (education) can result in more healthful outcomes.

Food insecurity is defined as the limited or uncertain availability of nutritionally adequate and safe foods or the limited or uncertain ability to acquire acceptable foods in socially acceptable ways (Anderson 1990). In the USDA's 2010 food insecurity report, 9.1 percent of American households lived with low food security, while 5.4 percent of households were in the lowest category, very low food security. In total, 14.5 percent or roughly 17.2 million households were food insecure at some point in 2010. Only 59 percent of these households participated in a food assistance program (Nord et al 2010). These figures have increased since 2008 and suggest food insecurity is a growing problem in the United States.

The cause of food insecurity in the U.S. has traditionally focused on statistics indicating that food insecure households have fewer resources, such as income. In analyzing summary statistics, Nord et al. (2010) find that households living with low incomes are more likely to be food insecure compared to those with higher incomes. Leete and Bania (2010) also conclude that income levels and negative income shocks have a statistically significant effect on the probability of being food insecure. In addition, Gunderson et al. (2011) find that the probability of food insecurity declines with income. This decline is most significant among marginally food insecure households. The effect of limited resources, like income, on health outcomes is also documented in the literature. Basiotis and Lino (2002) and Drewnowski (2009) find that households faced with significant income constraints are incentivized to purchase cheap, unhealthful foods. These purchases allow food insecure household to purchase more calories per dollar, at the expense of nutritional quality. Therefore, as households compensate for limited resources by purchasing unhealthful foods, they increase their likelihood of having negative health events down the road.

The traditional cause of fewer resources does not seem to be the only contributing factor to household food insecurity. As mentioned in the introduction, recent data suggests that 59.8 percent of households living below the poverty index were food secure throughout 2010 (Coleman-Jensen et al. 2011). Gunderson et al. (2011) also find in their study that poverty is not necessary synonymous with food insecurity—about sixty five percent of households surveyed, living near the poverty line, were food secure. This compares to twenty percent of households surveyed, living comfortably above the poverty line, who were food insecure. Nord et al (2010) additionally summarize that food insecurity increases when the head of household is less educated compared to those with more education. The summation of this literature suggests that limited resources, like income, are not the sole determinants of food insecurity. Alternatively, limited education may also increase the likelihood of food insecurity.

The connection between education and unhealthful food choices, which increase the risk of obesity, is also documented. Finkelstein (2008) finds that overweight individuals (BMI>25) are less likely to have completed a college education compared to individuals with normal weight. Furthermore, he finds that obese respondents (BMI>30) are even less likely to have completed a college education when compared to individuals with normal weight. Burton et al. (2005) find that the levels of calories, fats, and saturated fats in unhealthful foods are typically underestimated by uniformed consumers. When consumed in abundance, these unhealthful foods increase the risk of obesity (Hartline-Grafton et al. 2009; Howarth et al. 2006). In a study by Bhattacharya et al (2004), they find that food insecure adults have less healthy diets when compared to food secure adults. Additionally, their level of food insecurity is a positive predictor of their obesity level. Similar results from Dinour et al (2007) find a correlation between food insecurity and obesity, especially among adult women.

The potential consequences of obesity due to unhealthful food choices are staggering. Medical expenses, on average, are roughly 37 percent higher for obese individuals (Finkelstein et al. 2003). Obesity is responsible for about 9.1 percent or roughly 92.6 billion health expenditures each year. In addition, obesity is associated with increases in illness such as heart disease and diabetes as well as lower life expectancies (Must et al. 1999; Mokdad et al. 2003; Fontanine et al. 2003). Based on the costs associated with obesity due to unhealthful food choices and assuming food insecure households are rational, an efficient allocation of resources should be made towards healthful foods and the production of health.

Several papers that discuss human capital models provide theoretical support for our hypothesis. In Grossman's (1972) seminal paper examining individual health production, he determines that health production and health stock can be increased over time with investments made in human capital, including education. Specifically, he finds that the shadow price of health falls in relation with education. He suggests that education, when entering into production, increases the efficiency of the process. Therefore higher educated individuals are more efficient producers of health, improving nonmarket productivity. This suggests that investments made in education play an important role in increasing healthful outcomes.

Michael (1973) adds to the literature by investigating whether investments in human capital by a household yield returns in productivity outside the labor market. To examine this, he empirically models the impact of schooling on household expenditures. His framework relies on the premise that education affects nonmarket outcomes and can possibly directly alter the household utility function, producing expenditure shifts. He finds that education raises nonmarket productivity by three-fifths more than market productivity. He also suggests that household consumption bundles changes as the head of household's education level increases. The implication is that heads of households with higher levels of education behave as though they have more disposable real income. Michael's paper suggests that higher levels of education in a household's production function also increase efficiency of production and nonmarket productivity.

Grossman (2005) addresses the impact of schooling on nonmarket and market outcomes such as health and consumption bundles, respectively. He examines the theoretical argument made in Becker (1965) which states that increases in knowledge and years of schooling will increase efficiency in nonmarket outcomes. Additionally, he uses empirical evidence from his previous work to examine this assumption. He concludes that traits developed by schooling influence decisions made at work and at leisure, such as, whether to smoke cigarettes, what kind of food to buy and what portion of income to save. This supports previous literature finding that nonmarket outcomes like consumption patterns, rates of saving, own health, inputs into healthcare and child well-being are highly affected by education. He concludes that general interventions that encourage better future oriented behavior may have much larger rates of return in the long run then specific interventions designed for that purpose.

Quantifying the effects of education on actual household expenditures, especially healthful expenditures, represents a significant gap in the literature. This paper contributes to the literature by estimating the specific effect of investing in human capital, particularly education, on efficient outcomes such as healthful food purchases among the most vulnerable in society, food insecure households.

III. Data

The data for this study comes from the diary component of the 2009 Consumer Expenditure Survey (CE) provided by the Bureau of Labor Statistics (BLS). This short panel data set consists of 14,623 observations with 7,200 households participating in week one of the diary and 7,423 households participating in week two of the diary. Overall there are 7,683 households that participate in week one and two of the survey. The diary component seeks to obtain data on frequently purchased items such as food and nondurable goods which households are less likely to remember over time. The diary requires households to record expenditures on several categories of goods daily. At the end of one week, the diaries are collected and a new diary is given to replicate the process for week two.

The households are also subjected to quarterly interviews, in which they report demographic and household characteristics along with durable goods purchased. The demographic and household characteristics can be combined with the diaries to provide a clear picture of each household and their expenditures. The BLS manipulates the raw data in several ways before providing it to the public. First, if households fail to report income information, the BLS uses an imputation method based on reported household characteristics. This provides five potential values for a missing income response and a mean of the five imputed values. For our purposes, we use the mean value when an income response is missing. Secondly, a small proportion of state codes are replaced by the BLS with codes of states other than the state where the household resides. This is done for privacy reasons. We account for this when controlling for state differences that may influence purchasing habits of households.

We make several modifications to the data set to get our final sample. We eliminate households who do not purchase any type of food in the two week period the diary was collected. If there is a nonrandom reason why households do not purchase food in the survey's two week period, we would need to control for this bias in our model. However, it is plausible to assume that zero food purchases over a two week period occur randomly for households that do not purchase food over this period. It may be the case that these households stockpile their grocery purchases. Dropping these zeros reduces our data set to 12,935 observations. These observations consist of 6,370 households who complete the diary in week one and 6,565 households who complete the diary in week two.

In the U.S., food insecurity is typically measured by the food security survey amended to the Current Population Survey (CPS). This addendum consists of eighteen questions specifically design to determine the level of food insecurity within a household. Beginning in 1996, the survey classifies households in four categories depending on how many questions are answered in the affirmative by a household. These categories are high food security, marginal food security, low food security and very low food security. Since this data is unavailable in the CE survey, we calculate a new variable based on the poverty index developed by the U.S. Department of Health and Human Services to estimate whether a household is food insecure. Though this variable is not meant to be an exact determinate of food insecurity, it is used as a proxy to food insecurity status. This is supported by Barnes and Smith (2009) who use the poverty index as a proxy for insecurity levels.

Because household size could significantly impact many of the expenditure variables, like food purchases, we express household expenditures and income on a per capita basis. In addition, we use unweighted values of the data in this study[1]. Finally, for each household we identify the highest level of education for each household and the age of the oldest person for each household. Table 1 provides a summary of the household demographics. Table 2 provides a mean comparison between food secure and food insecure households. This table demonstrates the distribution of demographic characteristics between the two groups. Table 3 provides mean differences between households with zero food purchases and households with food purchases also demonstrating that the demographics are distributed similarly between the two groups.

IV. Empirical Model

To examine the effect of education on the expenditure of fresh fruits and vegetables we consider the following model:

$$Y_i = \alpha_i + \beta E_i + \delta X_i + \eta RACE_i + \theta MONTH_i + \lambda STATE_i + \varepsilon_i, \tag{1}$$

where Y_i is per capita expenditure on fresh fruits and vegetables by household i; E_i is the education level for household i; X_i are demographic characteristics including age, per capita income before taxes and a monthly consumer price index for the month when the diary was completed for household i; $RACE_i$ is a dummy indicating the race of the head of household i; $MONTH_i$ is a dummy indicating the month of the diary for household i; $STATE_i$ is a dummy

[1] Literature suggests weights are unnecessary for determining causal relationships. Cameron and Trivedi (2005) explicitly state weights are unnecessary when the interest lies in the regression of y on x provided the model for y, given x, is correctly specified. Woodridge (2002) even suggests that unweighted estimators are consistent and more efficient than weighted estimators in the presence of heteroscedasticity. To be assured of this outcome, we estimated our model with weighted least squares and found no significant change in the results compare to the unweighted values presented.

indicating the state where household i resides and finally ε_i idiosyncratic error term for household i.

The most concerning problem with this model is selection bias due to unobservable characteristics correlated with household education as well as household expenditure on fresh fruits and vegetables. Failing to account for such unobservable characteristics would bias our estimates from the model. For example, a more motivated individual may strive to achieve higher levels of education while also striving to be healthier. This motivation characteristic would affect the amount of fresh fruits and vegetables purchased as well as the level of education pursued. Therefore, OLS estimates would likely overstate the impact of education because of unobserved levels of motivation. The most common correction method to control for selection bias due to unobservable characteristics is an Instrumental Variable approach. However, lacking an appropriate instrument, the IV method can be problematic and potentially worse than OLS. For these reasons, we avoid an Instrumental Variable approach.

We take several alternative approaches to deal with selection bias. First, we follow Bitler and Currie (2005) and Joyce et al. (2008) by introducing more covariates within the model to reduce the effect of selection on unobservables. Secondly, we attempt to compare outcomes among more narrowly defined treatment and control groups to reduce bias. Our first approach is to estimate our model on a reduced sample, with additional covariates, where selection on unobservables is less likely. Our data reveals that food insecure households have similar demographic characteristics as food secure households within our data set. Therefore we are able to partially reduce the presence of selection bias by focusing on food insecure households. Our model becomes:

$$Y_i = \alpha_i + \beta E_i + \delta X_i + \eta RACE_i + \theta MONTH_i + \lambda STATE_i + \varepsilon_i \, , \tag{2}$$

where X_i now includes additional control variables including marital status of the head of household i, household size of household i, number of earners in household i, and the number of children in household i. In addition, household i now includes only food insecure households. The use of this approach to control for selection bias has several potential drawbacks. By using a reduced sample, we are possibly increasing the level of bias by non-randomly selecting the sample for which OLS is performed. In addition, by focusing on food insecure households, we are potentially not controlling for selection bias that occurs within this group. This outcome is not optimal since we are interested in understanding how investments in education impact expenditures on fresh fruits and vegetables for food insecure households as well. Finally, we add several additional covariates that are possibly endogenous choices, which may increase the presence of endogeneity within our model. These drawbacks prevent this method from being the best solution to selection bias.

Additional literature suggests using a two step control function approach that reduces the bias from unobservable characteristics by selection on observable characteristics in the data set. Altonji et al. (2002, 2005) asserts that the amount of selection on observed explanatory variables in a model can provide a guide for the amount of selection on unobservable explanatory variables. His work uses a two step approach to reduce selection bias on a binary regressor that is correlated with an unobservable characteristic in the error term. The problem with applying Altonji's approach to our model is that our regressor, education, is a continuous variable.

Garen (1984) uses a similar two step approach with a continuous education variable to control for unobservable characteristics present in his model. He accomplishes this with the use of an ordered probit estimator, uncovering what characteristics affect an individual's level of education. Card (1999, 2001) also discusses the optimal level of education that results in the presence of heterogeneous benefits and Aakvik et al. (2003) use an ordered probit model to estimate the effects of control variables on school outcomes specifically how education affects individual earnings. The difficulty in using an ordered probit model for education in the first step is recovering the residuals. Residuals are needed for the second step in the selection correction procedure. In light of this, Aakvik et al. (2003) compute the generalized residuals for each education level based on the thresholds determined from the ordered probit. This provides a method for obtaining residuals that we adopt for the two step correction procedure.

To apply the two step correction procedure as first discussed by Garen (1984), we start with an ordered probit to estimate the effect of observable characteristics on a single latent variable, education level:

$$E_i^* = \beta_s Z_i + \xi_i, \tag{3}$$

In this model, E_i^* is the household education level as described in the data section; Z_i are the household observable characteristics such as age, gender, race and state; β_s is the effect of observable characteristics on educational attainment and ξ_i is our error term that is normally distributed with $E(0, \sigma^2)$. As E_i^* moves past a series of increasing thresholds, individuals select into differing levels of education. In a j-alternative ordered model, the level of education is described as $E_i = j$ if $cut_{\ j-1} < E_i^* \leq cut_j$, where $cut_{\ 0} = -\infty$ and $cut_j = \infty$. Therefore, the ordered probit model with $\Pr(E_i = j|Z_i)$ is calculated as:

$$\Pr\,(E_i = j|Z_i) = \Phi\big(cut_j - \beta Z_i\big) - \Phi(cut_{j-1} - \beta Z_i) \tag{4}$$

where Φ is the cumulative distribution function (CDF). Generalized residuals for each level of education can be obtained from the results of the ordered probit model. We use these generalized residuals for each education level to control for unobservable characteristics in our model that may impact education and household expenditure on fresh fruits and vegetables. The generalized residuals for each education level are calculated as:

$$\xi_{ij} = \frac{\phi(cut_{j-1} - \beta Z_i) - \phi(cut_j - \beta Z_i)}{\Phi(cut_j - \beta Z_i) - \Phi(cut_{j-1} - \beta Z_i)} \tag{5}$$

where ϕ is the normal probability density function (PDF). Following Garen (1984) and Aakvik et al. (2003) we include an interaction regressor, $E_i\xi_{ij}$ and a generalized residual regressor, ξ_{ij} similar to the usage of an inverse mills ratio. The model becomes:

$$Y_i = \alpha_i + \beta E_i + \delta X_i + \eta RACE_i + \theta MONTH_i + \lambda STATE_i + \tau E_i\xi_{ij} + \mu\xi_{ij} + \varepsilon_i \tag{6}$$

Applying OLS to this equation, results in unbiased and consistent estimates of the average effect of education on the expenditure of fresh fruits and vegetables.

V. Results

Several problems with this model could result in OLS estimates being biased and inconsistent. First, multicollinearity is potentially present within our model if education and income are correlated. This correlation would result in abnormally high variance, suggesting that our parameter estimates are not very precise. Since it is unlikely that education and income have an exact linear relationship, multicollinearity is not of much concern. However, if an approximate linear relationship exists, the precision of our estimates could be reduced. The presence of multicollinearity can be easily tested using the variances inflation factor, (VIF). Using this test, we find that our variance inflation factors do not exceed ten. Therefore multicollinearity is not a problem.

A second potential problem with this model is the presence of heteroscedasticity. It is unlikely that the variance of our error term is constant for all households, thus violating one of the classical linear regression assumptions. To control for this problem we include race, month, and state fix effects. Additionally, we use robust standard errors to ensure that any additional variation across households is accounted for. A third problem we consider is the presence of households with zero expenditure on fresh fruits and vegetables, our dependent variable. If theses zeros are nonrandom then a self selection bias is present. This would produce estimates that are inconsistent, even asymptotically. However, when using a Heckman two step procedure to correct for self selection bias, we find that the inverse mills ratio is insignificant, indicating self selection does not occur.

The results of our estimation approaches are found in table 4. When applying OLS to the entire sample, we estimate that an increase in education results in a 25 cent increase in per capita household expenditure on fresh fruits and vegetables per week. This is statistically significant at a .01 level. Our estimation also shows that age has a positive relationship with per capita household expenditure on fresh fruits and vegetables. This is consistent with our intuition; as individuals get older they consume healthier foods including more fruits and vegetables. As discussed above, without correcting for unobservable characteristics that cause selection bias, it is highly unlikely that these estimates are unbiased and consistent. Therefore these parameter estimates are likely misstated and do not reflect the true relationship between education and per capita household expenditure on fresh fruits and vegetables.

We proceed to estimation of equation 2, which attempts to correct for selection bias by including additional regressors. The results for OLS estimation of equation 2 are found in table 4, under column 2. First, when the full sample is estimated with additional regressors, we find that an increase in education results in a 28 cent increase in per capita household expenditure on fresh fruits and vegetables per week. This estimate is again statistically significant at a .01 level. This result is somewhat surprising since the effect has increased from the previous model. Interestingly we also find that age, household size, marital status, number of children and the number of household earners are statistically significant and with the exception of age and marital status, have a negative relationship with per capita household expenditure on fresh fruits and vegetables. A negative relationship between household size and per capita household expenditure on fresh fruits and vegetables suggests that as household size marginally increases, per capita expenditure decreases. This situation might be explained if households continue to purchase the same quantity of fruits and vegetables even as household size increases. Therefore, per capita fruit and vegetable expenditure declines. For marital status, our estimates suggest that being married increases per capita household expenditure on fresh fruits and vegetables. This result suggests that married couples are more efficient producers of health, combining resources and knowledge to purchase more fresh fruits and vegetables. Finally, the number of household earners has a statistically significant negative relationship with per capita household expenditure on fresh fruits and vegetables. A potential reasoning behind this relationship is that food away from home increases as the number of household earners increases. Furthermore, households might be forced to consume more calorie dense foods because household members require more calories for work. This could possibly reduce fruit and vegetable consumption.

To examine the impact of education on per capita household expenditure on fresh fruits and vegetables among food insecure households, we estimate equation 6 by OLS for food insecure households only. The results from this estimation are found in table 4, column 3. For the most part, the relationships found when estimating on all households hold for food insecure households. Education, age, marital status, and number of household children all have a statistically significant relationship with the same sign as found above. However, estimation on food insecure households results in larger slope effects and smaller intercept effects when compared to all households. Of interest is the coefficient for education. We estimate that an increase in education results in a 34 cent increase in per capita household expenditure on fresh fruits and vegetables per household. This coefficient is about 4 cents higher than the coefficient for education obtained when estimating all households. Though the increase could be representative of the differences between food insecure households and all households, it is not clear that selection bias has been reduced by focusing on a more narrowly defined treatment group. Our intuition suggests that by controlling for unobservable characteristics, our education coefficient would be the same or smaller than the coefficient found in the previous approaches.

The most accurate estimation approach to control for selection bias is the two step procedure with OLS estimation of equation 6 as put forth by Garen (1984). The results of this estimation approach for all households are found in table 4, column 4. We find that an increase in education results in 22 cent increase in per capita household expenditure on fresh fruits and vegetables. This estimate is statistically significant at a .05 level. In addition age, income, marital status, household size, and the number of household earners are statistically significant and have the same relationship as previous results. Also of interest are the two additional regressors included in equation 6: the generalized residuals obtained from the ordered probit and the interaction term. The coefficient estimates for these regressors are statistically significant indicating the presence of selection bias due to unobservable characteristics within our model. By adding these regressors, we have controlled for the bias and the possible overstated impact of education on per capita household expenditure of fresh fruits and vegetables. Therefore, education does have a positive causal relationship with per capita household expenditure on fresh fruits and vegetables. Specifically, an increase in the head of household's education results in a 22 cent increase in per capita household expenditure on fresh fruits and vegetables per week.

Finally, we estimate the two step procedure with OLS estimation of equation 6 for food insecure households only. We estimate that an increase in education results in a 1 dollar and 43 cent increase in per capita household expenditure on fresh fruit and vegetables per week. This is statistically significant at a .1 level. In addition to education, age and number of household children are also highly significant. Age has a positive relationship with per capita household expenditure on fresh fruits and vegetables while the number of household children has a negative relationship. The ordered probit generalized residuals added as an additional covariate in the second step are also significant, indicating that selection bias is present in the model. The interaction term is not significant in this estimation.

The results obtained when estimating solely on food insecure households compared to the results obtained when estimating on all households leads to an interesting conclusion concerning selection bias. When our two step correction procedure is performed on all households, we find a decrease in the coefficient for education compared to the coefficient resulting from ordinary OLS. This finding is consistent with our intuition—that selection bias produces an overstated impact of education. However, when our two step correction procedure is performed on food insecure households, we find an increase in the coefficient for education compared to the coefficient resulting from ordinary OLS.

Several hypotheses may explain this inconsistent result. First, unobservable characteristics may be negatively correlated with education but positively correlated with per capita household expenditure on fresh fruits and vegetables. If a family member of a food insecure household dies due to an illness related to unhealthful food choices, the opportunity for household members to increase education may decline. But the loss of a family member may increase awareness, resulting in the purchase of more healthful foods. Secondly, unobservable characteristics may be positively correlated with education but negatively correlated with per capita household expenditure on fresh fruits and vegetables. This might be explained by food insecure households who value education to increase income, but do not value healthful food choices. Further investigation into this outcome is needed.

VI. Conclusion

From this study, it is apparent that education plays an important role in producing efficient outcomes such as developing healthier lifestyles. To what extent education can reduce obesity and food insecurity is a difficult question to answer. But we can say with confidence, when considering all households, that increasing education results in a 22 cent increase in household expenditure on fresh fruits and vegetables per person per week. While to some this amount may seem unsubstantial, it does calculate to about one additional serving of fruit or one additional serving of vegetable per person, per week (Stewart 2011). Therefore improved education could play an important role in improving an individual's food choice. Further investigation and better data might improve our understanding of education's effect on consumption bundles. Ideally, an assessment of nutritional knowledge and its impact on food expenditures is needed. Improved nutritional knowledge might be more beneficial than general education and could result in more healthful food choices.

Current policy aimed at reducing food insecurity and obesity have had mixed results. These problems still affect large portions of the population. It is unlikely that any one policy option will contribute to a significant decline in food insecurity and obesity. With the increase in sedentary lifestyles, it becomes essential that households consume increased amounts of healthful foods and partake in healthful lifestyles. Programs aimed at increasing education could decrease unhealthful food consumption and possibly food insecurity. Transitioning some support from food assistance programs to nutritional education programs could lead to the best solution. Furthermore, unobservable characteristics like motivation, stress, and rationality must be considered when determining policies to reduce food insecurity and obesity. It is possible that weight loss and healthful eating is irrational for some individuals. This assumption should be questioned and may explain why current policies have not significantly altered unhealthful habits.

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Table 1. Summary Statistics

Variable	Observation	Mean	Std. Dev.	Min	Max
Education	12935	4.59	1.77	0	8
Age	12935	50.48	17.08	16	87
Per capita income (divided by 1000)	12935	30.62	28.56	0	365.19
Income (divided by 1000)	12935	67.72	61.51	0	.550
HH size	12935	2.54	1.45	1	11
HH earners	12935	1.32	0.93	0	7
HH children (18 and younger)	12935	0.63	1.05	0	8
Expenditures:					
Per capita fruit and vegetable (per week)	12935	4.35	6.11	0	81.08
Per capita food total (per week)	12935	59.20	53.57	0.17	1527.93
Per capita fruit (per week)	12935	2.22	3.63	0	51.07
Per capita vegetable (per week)	12935	2.13	3.53	0	69.66
Race		Percent			
White	10,711	82.8%			
Black	1,428	11.0%			
Native	69	0.5%			
Asian	529	4.1%			
Pacific	52	0.4%			
Multi	146	1.1%			
Married	7,027	54.3%			
Not Married	5,908	45.7%			
Education Level					
0 - Never attended school	19	0.2%			
1 - First through eighth grade	403	3.1%			
2 - Ninth through twelve grade	798	6.2%			
3 - High school graduate	3,026	23.4%			
4 - Some college	2,604	20.1%			
5 - Associate's degree	1,220	9.4%			
6 - Bachelor's degree	2,860	22.1%			
7 - Master's degree	1,437	11.1%			
8 - Professional/Doctorate degree	568	4.4%			

Table 2. Mean Comparison Food Insecure and Food Secure				
	Food Insecure		Food Secure	
Variable	Observations	Mean	Observations	Mean
Education	1365	3.47	11570	4.72
Age	1365	43.88	11570	51.26
Per capita income (divided by 1000)	1365	4.28	11570	33.73
Income (divided by 1000)	1365	8.98	11570	74.65
HH size	1365	2.47	11570	2.54
HH earners	1365	0.68	11570	1.39
HH children	1365	0.91	11570	0.60
Expenditures:				
Per capita fruit and vegetable (per week)	1365	3.40	11570	4.46
Per capita food total (per week)	1365	44.57	11570	60.92
Per capita fruit (per week)	1365	1.69	11570	2.28
Per capita vegetable (per week)	1365	1.71	11570	2.18
Race		Percent		Percent
White	1,010	74.0%	9,701	83.8%
Black	269	19.7%	1,159	10.0%
Native	20	1.5%	49	0.4%
Asian	35	2.6%	494	4.3%
Pacific	6	0.4%	46	0.4%
Multi	25	1.8%	121	1.0%
Married	351	25.7%	6,676	57.7%
Not Married	1,014	74.3%	4,894	42.3%
Education Level				
0 - Never attended school	6	0.4%	13	0.1%
1 - First through eighth grade	126	9.2%	277	2.4%
2 - Ninth through twelve grade	210	15.4%	588	5.1%
3 - High school graduate	403	29.5%	2,623	22.7%
4 - Some college	348	25.5%	2,256	19.5%
5 - Associate's degree	90	6.6%	1,130	9.8%
6 - Bachelor's degree	137	10.0%	2,723	23.5%
7 - Master's degree	39	2.9%	1,398	12.1%
8 - Professional/Doctorate degree	6	0.4%	562	4.9%

Table 3. Mean Comparison Zero Food Purchases and Positive Food Purchases

Variable	Zero Food Purchases Observations	Mean	Food Purchases Observations	Mean
Education	1688	4.35	12935	4.59
Age	1688	51.45	12935	50.48
Per capita income (divided by 1000)	1688	24.55	12935	30.62
Income (divided by 1000)	1688	44.23	12935	67.72
HH size	1688	2.08	12935	2.54
HH earners	1688	1.01	12935	1.32
HH children	1688	0.41	12935	0.63
Expenditures:				
Per capita fruit and vegetable (per week)	1688	0	12935	4.35
Per capita food total (per week)	1688	0	12935	59.20
Per capita fruit (per week)	1688	0	12935	2.22
Per capita vegetable (per week)	1688	0	12935	2.13
Race				Percent
White	1,388	82.2%	10,711	82.8%
Black	198	11.7%	1,428	11.0%
Native	10	0.6%	69	0.5%
Asian	68	4.0%	529	4.1%
Pacific	3	0.2%	52	0.4%
Multi	21	1.2%	146	1.1%
Married	700	41.5%	7,027	54.3%
Not Married	988	58.5%	5,908	45.7%
Education Level				
0 - Never attended school	0	0.0%	19	0.2%
1 - First through eighth grade	70	4.1%	403	3.1%
2 - Ninth through twelve grade	131	7.8%	798	6.2%
3 - High school graduate	455	27.0%	3,026	23.4%
4 - Some college	338	20.0%	2,604	20.1%
5 - Associate's degree	148	8.8%	1,220	9.4%
6 - Bachelor's degree	332	19.7%	2,860	22.1%
7 - Master's degree	146	8.6%	1,437	11.1%
8 - Professional/Doctorate degree	68	4.0%	568	4.4%

Table 4. OLS Results					
Per Capita Expenditure of Fruits and Vegetables	Model (1) All Households	Model (2) Additional Covariates All Households	Model (3) Additional Covariates Food Insecure Households	Model (4) Two Step Correction All Households	Model (5) Two Step Correction Food Insecure Households
Education	0.255***	0.281***	0.343***	0.220***	1.439*
	(0.036)	(0.037)	(0.122)	(0.078)	(0.872)
Age	0.052***	0.037***	0.064***	0.035***	0.071***
	(0.003)	(0.004)	(0.011)	(0.004)	(0.015)
Per Capita Income	0.028***	0.023***	0.051	0.021***	0.056
	(0.000)	(0.003)	(0.064)	(0.003)	(0.064)
CPI	0.016	0.023	0.032	0.026	0.019
	(0.025)	(0.025)	(0.057)	(0.025)	(0.057)
Marital		0.429***	1.052***	0.502***	0.609
		(0.118)	(0.388)	(0.121)	(0.421)
HH size		-0.498***	-0.544***	-0.516***	-0.590***
		(0.075)	(0.162)	(0.075)	(0.178)
HH Earners		-0.255***	0.246	-0.237***	0.180
		(0.071)	(0.265)	(0.071)	(0.237)
HH Children		0.053	0.290	0.035	0.351*
		(0.079)	(0.185)	(0.079)	(0.202)
Black	-0.587***	-0.603***	0.061	-0.651***	0.225
	(0.167)	(0.167)	(0.346)	(0.173)	(0.371)
Native	-0.403	-0.238	1.209	-0.215	0.854
	(0.661)	(0.659)	(1.707)	(0.660)	(1.797)
Asian	1.081***	1.140***	1.609	1.201***	1.698
	(0.320)	(0.318)	(1.517)	(0.323)	(1.498)
Pacific	-1.914***	-1.746***	0.601	-1.665***	-0.535
	(0.513)	(0.496)	(1.231)	(0.497)	(1.569)
Multi	-0.559	-0.671	0.199	-0.686	-0.855
	(0.477)	(0.474)	(0.939)	(0.465)	(1.242)
Education*Residual				0.170***	-0.006
				(0.031)	(0.126)
Residual				-0.591***	-1.716*
				(0.167)	(1.000)
Constant	-6.171	-6.224	-12.075	-7.108	-11.992
	(7.746)	(7.728)	(17.688)	(7.710)	(17.841)
Observations	12,880	12,880	1,313	12,880	1,313
R-squared	0.081	0.094	0.170	0.096	0.181

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1