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THE IMPACT OF STATE-LEVEL NUTRITION-EDUCATION PROGRAM FUNDING ON BMI: EVIDENCE FROM THE BEHAVIORAL RISK FACTOR SURVEILLANCE SYSTEM

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ABSTRACT

Currently, there is insufficient evidence regarding which policies will improve nutrition, reduce BMI, the probability of obesity and the probability of overweight nationwide. This preliminary study investigates the impact of a nutrition-education policy relative to price policy as a means to improve nutrition and reduce BMI. Model estimations are created with pooled cross-sectional data from the Centers for Disease Control's (CDC), Behavioral Risk Factor Surveillance System (BRFSS), American Chamber of Commerce Research Association (ACCRA) state-level food prices and the United States Department of Agriculture's (USDA) funding of state-specific nutrition-education programs from 1992 – 2006. During this period, federal funding for state-specific nutrition-education programs rose from approximately $600 thousand for a few states to nearly $248 million for all states. After controlling for state fixed effects, year effects and a state specific linear time trend, I find that nutrition education spending has the intended effect for individuals from certain, but not all, income and education-levels. Also, the results indicate that increasing the price of food purchased for consumption away from home is consistent with decreasing BMI, obesity and overweight for the lowest income groups. However, the overall effect is minimal.

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1. Introduction

The average US Body Mass Index (BMI), defined as weight in kilograms divided by height in meters squared (kg/m^2), has increased dramatically since the 1980s. Due to this rise, more Americans are classified as overweight (BMI > 25 kg/m^2) and obese (BMI > 30 kg/m^2). This increase has serious implications for the state of national health. A substantial amount of cross-disciplinary research has investigated the potential reasons for the increase. The economics literature attributes the dramatic increase with the hypothesis: the increase in average BMI is the result of economic changes that alter Americans' preferences for exercise and high calorie, low-nutrient food and drinks (Philipson, 2001; Lakdawalla and Philipson, 2002; Cawley,1999; Cutler, Glaeser and Shapiro, 2003; Chou, Grossman and Saffer, 2004).

To determine the impact of relative prices, more targeted economic research has investigated the impact of food prices and income levels (Auld and Powell, 2008; Beyoun, Powell, Yuan, 2008; Goldman, Lakdawalla, and Zheng, 2009), restaurant location and advertising (Chou, Rashad and Grossman, 2008; Rashad, Grossman, Chou, 2006), and prices of non-food items (e.g., soda prices) on BMI and obesity prevalence (Fletcher, Frisvold, Tefft, 2010). These studies all indicate technological change causes reductions in food and non-food prices and increases in access to high-calorie, low-nutrient food, which then shifts the nutritional content of processed food and the nutritional choices of Americans. To incentivize proper nutrition, economic policy typically alters the price of and/or access to low-priced foods that offer lower nutritional content. However, invoking policies affecting access or price may result in regressive effects that disproportionately and negatively impact those who are more disadvantaged or part of a lower income group. For this reason, other strategies that directly target consumer information may be more effective in reducing demand without imposing regressive losses on the most economically vulnerable.

This paper offers a preliminary study of the impact of federal spending on nutrition-education programs on BMI, obesity and overweight. Despite a wealth of research on nutrition-education programs from other disciplines, such as public health and nutrition, the current economic literature fails to provide an economic analysis that compares different policies and their overall effects on BMI, obesity and overweight. This paper contributes to the economic literature in two ways. First, it investigates the impact of nutrition education policy on individual-level weight outcomes. Second, the relative impact of nutrition-education policy and price policy is considered. This study uses individual-level data from the 1992-2006 Behavioral Risk Factor Surveillance System (BRFSS) for each state. These data are augmented with state-specific federal nutrition-education program funding levels and food prices over the same time period.

In addition, to my knowledge, this is the first study in any discipline to investigate the impact of nutrition-education policy across states. Therefore, this study is an important addition to the general investigation of the impact of price policy on weight outcomes. Extant studies that investigate price policy have done so using state-fixed effects to control for state-level attitudes and strategies to combat obesity. This paper improves on the previously described strategy from the price policy literature by holding actual state-level policies and annual expenditures to combat obesity constant in models that use state-fixed effects, year-fixed effects and state-specific time trends. The model design, described in more detail later, provides direct estimates of policy and expenditure impacts on BMI and obesity outcomes.

This study provides new and important information about the effectiveness of state-level policies designed to reduce obesity.

2. Background

2.1 BMI Growth

Table 2 documents the large increase in prevalence of overweight and obesity among individuals 18 years of age and older between 1976 and 2004. The 19% increase in overweight and 55% increase in obesity over the roughly 15 - year period between NHANESII and NHANESIII generated considerable concern. Obesity prevalence continued to rise by 42% over the roughly 15 years from NHANES (1988 – 1994) to NHANES (2003 - 2004), while over the same time-period the increase in the prevalence of overweight remained fairly constant at about 18%.

Table 2: Prevalence of Overweight and Obesity Among U.S. Adults

	NHANES II (1976-80) (n=11,207)	*NHANES III (1988-94) (n=14,468)*	*NHANES (1999-2000) (n=3,603)*	*NHANES (2001-02) (n=3,916)*	*NHANES (2003-04) (n=3,756)*
Overweight	47.0	55.9	64.5	65.7	66.2
Obese	15.0	23.2	30.9	31.3	32.9

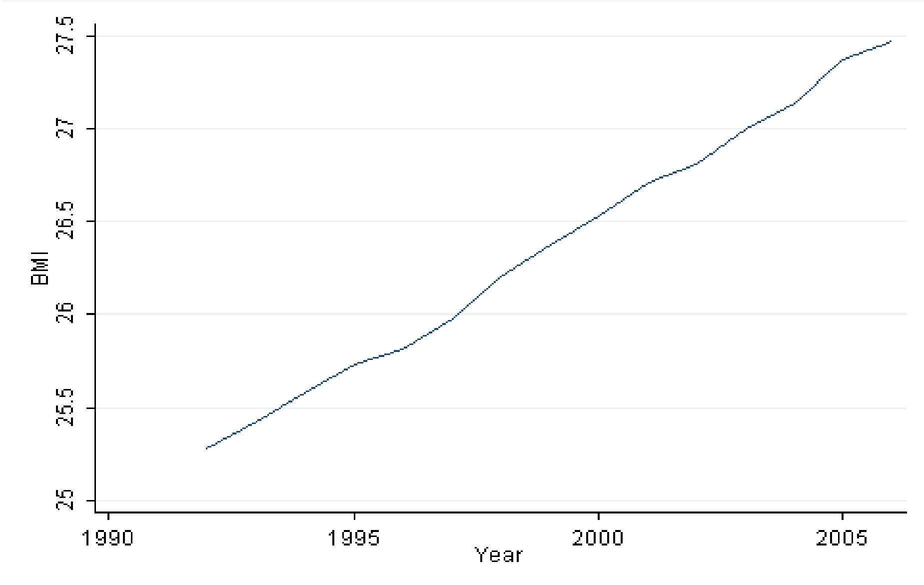
Source: www.cdc.gov/nchs/products/pubs/pubd/hestats/overweight/overwght_adult_03.htm.

Data from the BRFSS provide additional evidence of these trends. As can be seen in Figure 1, the average BMI for the US population increased by roughly 7% from 1995–2006. [3] The persistence in the trend is of interest to policy makers because the increase in the average BMI continued even after the problems associated with increasing BMI and obesity were identified. Additionally, the rise in the average BMI continues while expenditures on weight-

[3] BMI is not a perfect measure of overall fatness or health of an individual. However, given the current state of the literature I selected BMI, because it is the most widely accepted measure of obesity. For further information, see Burkhauser and Cawley, 2008.

loss services and products designed to aid weight reduction, including medical procedures and pharmaceuticals are rising (Reuters, April 21, 2009).

Figure 1: Average BMI growth in the US



2.2 Associated Medical Complications and Costs

The literature on obesity has been growing rapidly since the mid-1990s. The importance and salience of the research derives from well-documented adverse health outcomes associated with obesity and overweight (McGinnis and Foege, 1993; Allison et al., 1999). Obesity and overweight are currently associated with an increased risk of coronary heart disease, type-2 diabetes, certain cancers (endometrial, breast, and colon), hypertension, high cholesterol, stroke, liver and gallbladder disease, sleep apnea and respiratory problems, osteoarthritis, and gynecological problems (Kahn, et. al, 1997).

In 2006, the estimated medical costs associated with obesity were $147 billion (2008 dollars) (Finkelstein, et al., 2009). At the individual level, persons with a BMI in the obese range increase their medical expenditures by $1,429 (2008 dollars) per year when compared to counterparts with a healthy BMI (Finkelstein, et al. 2009). Previously, a study using data from the Medical Expenditure Panel Survey (MEPS) and the National Health Accounts (NHA) found that medical spending on obesity ranged from US$26.8 to US$47.5 billion dollars per year, as described in Table 1 from Finkelstein, Fiebelkorn and Wang (2003).

Table 1: Aggregate Medical Spending, in Billions of Dollars, Attributable to Obesity, by Insurance Status and Data Source, 1996–1998

Insurance Category	**Obesity**	
	MEPS (1998)	**NHA(1998)**
Out-of-pocket	$3.8	$6.9
Private	$9.5	$16.1
Medicaid	$2.7	$10.7
Medicare	$10.8	$13.8
Total	**$26.8**	**$47.5**

Calculations based on data from the 1998 Medical Expenditure Panel Survey (MEPS) and health care expenditures data from National Health Accounts (NHA). **Source**: Finkelstein, Fiebelkorn, and Wang (2003).

Table 1 illustrates that obesity also places a significant burden on publicly-funded programs. In 1998, approximately 42% of the obesity-related costs were publicly financed, as described by Table 1. In fact, the public funding of overweight and obesity rivals the amount of public funding associated with smoking (National Center for Tobacco Free Kids, 2002).

2.3 Policies to Combat Obesity

As mentioned previously, the main conclusion in the economics literature is that due to evolving technological change has correlated with a sustained increase in calorie consumption relative to calorie expenditure. The literature varies in identification of the causal mechanism of this imbalance. To date, the literature has focused on the implications of price policy as a tool to effect a change away from high-calorie, low-nutrition food (Philipson ,2001; Lakdawalla and Philipson, 2002; Auld and Powell, 2008; Beyoun, Powell, Yuan, 2008;

Cawley, 1999; Cawley, Lakdawalla, and Philipson, 2002; Chou, Grossman, and Saffer, 2004; Chou, Rashad, Grossman, 2008; Goldman, Lakdawalla, Zheng, 2009; Fletcher , Frisvold, Tefft, 2010; Rashad, Grossman, Chou, 2006). An understudied mechanism for change is nutrition-education policy. Nutrition-education policy could be a successful means to reduce individual-level BMI, particularly among higher income, more highly-educated consumers (Chaloupka, 1991). In fact, recent economic literature has found that spending on education programs can be a successful means to induce other healthy behaviors. For example, the literature on anti-smoking campaigns has found that cigarette sales and anti-smoking campaign funding are inversely related (Farrelly, et al., 2003).

Other disciplines have devoted more attention to assessing existing nutrition-educational programs relative to economics. Clinical studies have found that nutrition-education has been effective in reducing the risk of chronic diseases such as heart disease, diabetes and obesity (Lasker et al., 2008; Dansinger, 2005). In addition, some specialized research has demonstrated the effectiveness of nutrition-education programs in small clinical trials (Connelly, et al., 2007). Other studies have examined the impact of nutrition education on college students, finding a positive effect on nutrition and weight reduction (Clifford, et al. 2009; Byrd-Williams, et al., 2009). Given the suggestive evidence from smaller studies, it seems likely that broad-scale federal funding of state nutrition-education programs may be an effective means to reduce the prevalence of overweight and, more specifically, obesity without implementing tax or other pricing policies, which are regressive and strongly opposed by corporations and interest groups.

2.3.1 Background on Federal Nutrition-Education Funding Program

Funding: Federal and Non-federal Public Nutrition Programs

Federally, nutrition and obesity education is delivered through the United States Department of Agriculture (USDA). The USDA relies on state-level public entities, public schools (school systems and universities), public health clinics, etc. to extend information to the population. The USDA funds these programs through grants and other contracts to the states' health departments. Many of the programs are funded by the USDA through the Supplement Nutrition Assistance Program (SNAP). Therefore, SNAP created the Supplemental Nutrition Assistance Program's Education Program (SNAP-ed) to distribute the federal nutrition-education funds. SNAP-ed is a dollar-per-dollar federal match to all non-federal public funds already allocated at the state-level for the delivery of nutrition-education programs.

The USDA started allocating funds through SNAP-ed in 1988 with a grant to Wisconsin. By 1992, USDA distributed $661,000 across seven states (Wisconsin, Minnesota, Ohio, New Hampshire, New York, Oklahoma, and Washington). By 2004, fifty states participated in the program and they received a combined total of $228.2 million.

State-level Federally Funded Programs

Currently, the USDA regulation 7 CFR 272.2 gives states the *option* of participating in the program by applying for the federal match. Although participation is not mandatory, it is strongly encouraged. The main objective is to improve the likelihood that persons *eligible* for SNAP will make healthy food choices and choose physically active lifestyles. The goals are consistent with the current Dietary Guidelines for Americans for the general US population (U.S. Department of Health and Human Services and the U.S. Department of Agriculture, 2005).

Limited guidance is provided to the states regarding the structure of state nutrition education programs. In general, states are encouraged to use "the most effective nutrition education tools and strategies available" to develop interventions focusing on the following key behavioral outcomes:

1. Eat fruits and vegetables, whole grains, and fat-free or low-fat milk products daily.
2. Be physically active every day.
3. Balance caloric intake from food and beverages with calories expended.

Interventions range from broad social marketing campaigns, to the provision of a comprehensive nutrition education curriculum, to an individual or group (direct intervention). The indirect interventions involve social marketing campaigns which disseminate information and messages in a variety of ways, from recipe cards and wristbands to flyers and television or radio public service announcements. The variability in the delivery approach may result in somewhat diffuse treatment effects despite a fairly uniform overall use of learner-centered and behavioral-focused interventions. One representative state, Indiana, offered direct education programs in the following settings: local cooperative extension offices, youth education sites (preschools and day care), emergency food assistance sites, elderly services site, WIC clinics, adult education and training sites and churches/other faith based organization sites. The indirect materials used by programs in the state of Indiana included widely disseminated print material and participation in public events. Given the focus of Indiana's program, 90% of the participants are adults (18 years old or older). In comparison, Michigan, one of the first recipients of the funds, offers a well developed program that targets both direct education and indirect education through multiple venues. The direct education sites include all the direct education venues listed for Indiana plus the following additional sites: public schools (K-12), food stores or other retail outlets and health care sites. The indirect education includes mass communication (radio, television, newspapers, posters), print materials and participation in public events. The demographic profile of Michigan's program is estimated to be 52% school aged children (5 to 17 years old) and infants (less than 5 years old) and 48% adults (18 years old or older) (USDA, 2004).[4]

3. Analytical Framework

Any behavioral model aimed at describing BMI must include the energy balance equation, defined as the difference between energy consumed and energy expended (Chou et al., 2002; Chou et al., 2004; Philipson, 2001). If the energy consumed is greater than the energy expended and the imbalance persists over time, an increase in BMI results. If marginal increases in BMI persist, overweight could become obesity. To counteract the growth in an individual's BMI, the imbalance must be reversed. However, constraints may impede an individual's ability to reverse the energy imbalance and reduce their BMI. Some constraints are exogenous, for example age and genetics, while others, such as knowledge and prices may be influenced by policy.

A health production framework that incorporates the energy balance framework can be used to model improvements in health as providing utility (Grossman, 1972). When applied to nutrition and weight gain, an individual is assumed to gain utility from alterations to the production process that balances energy intake and output resulting in healthy weight. Disutility results from a BMI that is outside of the healthy (normal) range ($18.5 \text{ kg/m}^2 \leq \text{BMI} < 25 \text{ kg/m}^2$). With this in mind, a BMI outside of the normal range, according to economic

[4] At the time of this writing the only data available regarding the state-specific programs was from 2004.

theory, must result from changes to the production process or from changes in the prices of inputs to the production process. If BMI increases over time to be consistent with utility maximization or the household production frameworks, then BMI must be a by-product of some other production process, such as leisure. Chou, Grossman and Saffer (2004) conceptualize the rise in obesity as a by-product. Household production of other commodities, such as leisure, which can include dining out with friends, may produce effects that negatively impact weight and health. Alternatively, leisure could also be conceptualized as an input to health production with negative or positive marginal product depending on its effect on BMI. In either conceptualization, negative effects may be moderated by improved information or education about the health production process and the caloric content of inputs to it (e.g. nutrition-education).

In this paper, the production of an undesirable BMI is conceptualized as a by-product of household production. Reductions in information asymmetries about caloric and nutritional content through nutrition-education resulting in more efficient health production can be viewed as managerial shifts in the household production process that reduce the by-production of weight gain (Grossman, 1972). This mirrors other production processes where economic research has shown that on-the-job training and on-the-job learning increases production efficiency (Mincer, 1984; Barron, et al. 1989). Training and educational programs with a targeted purpose, such as increased health production, should similarly reduce BMI and the probability of an individual being overweight or obese. Within this framework, we also test the hypothesis that BMI and weight outcomes are influenced by the stock of information rather than the within period flow.

4. Data Description and Empirical Implementation

4.1 The Behavioral Risk Factor Surveillance System (BRFSS)

Three individual-level outcomes are investigated: 1) actual BMI, 2) an indicator that the individual's BMI is above the normal range (overweight) (BMI ≥ 25 kg/m^2), and 3) an indicator that an individual's BMI-level is in the obese range (obese) (BMI ≥ 30 kg/m^2). The individual-level variables and all demographic variables used to describe the three weight outcomes derive from repeated cross-sections of the BRFSS, an annual telephone survey of persons 18 years and older. Surveys are conducted by each participating state's health department and administered by the Centers for Disease Control and Prevention (CDC). The CDC uses BRFSS to calculate national and state-specific estimates of the prevalence of lifestyles and behaviors that contribute to various health outcomes, including obesity.

Fifteen states participated in the first survey in 1984. State participation rose to 49 states by 1992 and all 50 states by 1996. During this time, the respondent participation in the BRFSS rose from 96,213 in 1992 to 355,216 in 2006. The final analysis sample for the pooled cross-section 1992-2006 includes 2,262,952 individuals from 1992-2006.[5] As was seen in Figure 1, the U.S. average BMI increased by 2.10 kg/m^2, or approximately 7% between 1992 and 2006.

[5] Guam and the U.S. Virgin Islands are not included in our sample.

Figure 2: Prevalence of Overweight and Obese

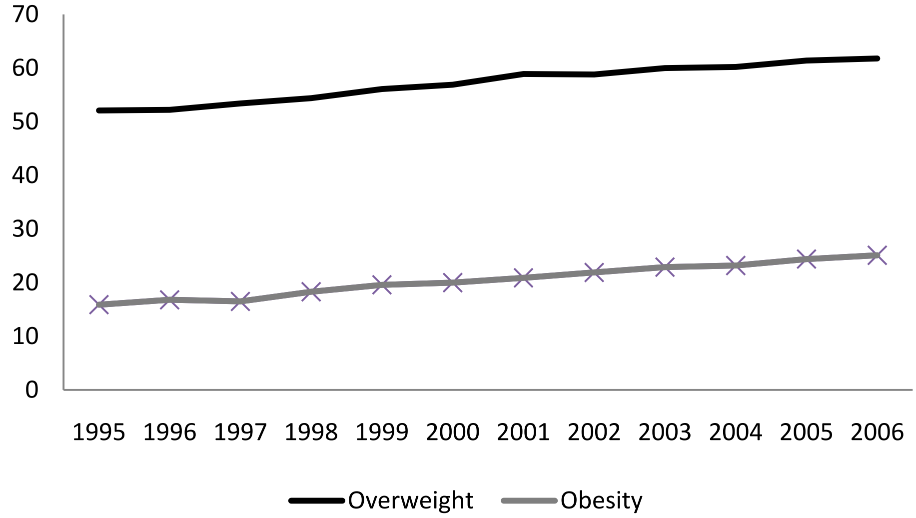


Figure 2 provides evidence of the growth in the prevalence of overweight and obesity within the US as described by BRFSS. The growth in obesity is fed by those transitioning from a BMI in the overweight range to a BMI in the obese range. Therefore, by focusing on overweight rather than individual categories allows for a more accurate picture of the "fattening" of the US population. Over the time-frame of study, the prevalence of overweight in the BRFSS increased from 1992 to 2006 by nearly 35%.

Further analysis of the individual-level variables used in the empirical model reader is found in Table 3, which presents the descriptive statistics for the variables for the 1992-2006 time frame. The variables include measures of age, gender, marital status, education-level, employment and income-levels. The income-levels are used to create a real income variable (in 1984 dollars) for consistency with the other variables that measure prices and funding. A description of the state-level price and funding variables presented in Table 3 are provided in subsequent sections.

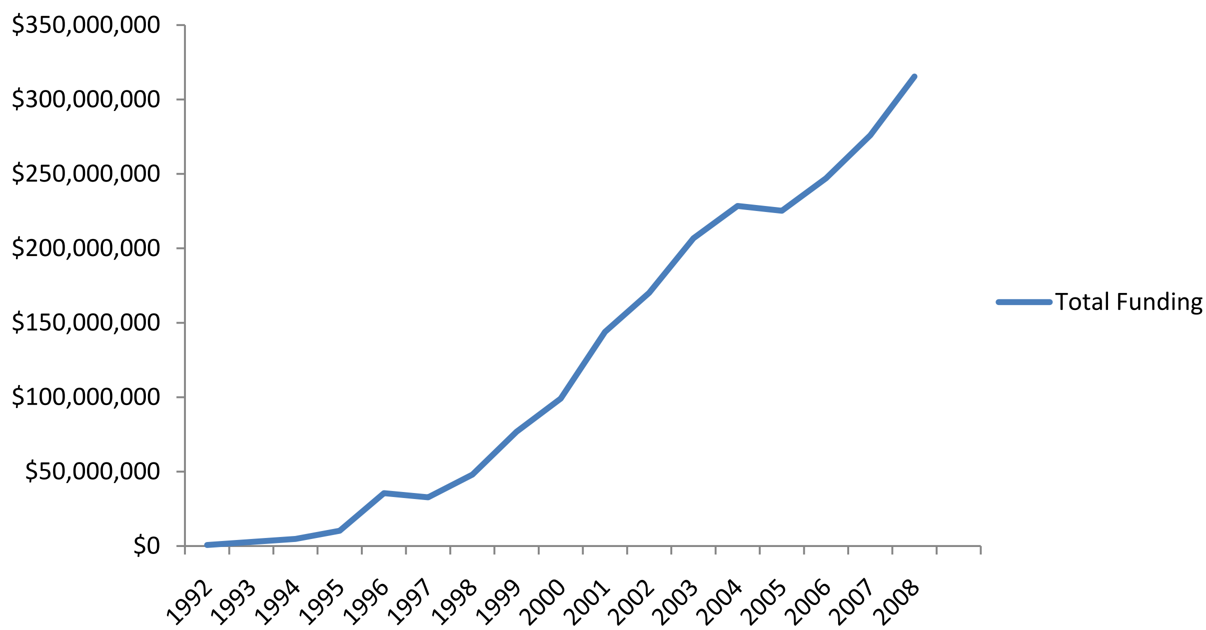
Table 3: Definitions means and standard deviation of the variables.

Variable	Definition	Mean	Standard Deviation
BMI	Weight in Kg/height in meters^2	26.658	5.479
Obese	Dichotomous Variable = 1 if BMI in the obese	0.215	0.412
Overweight	Dichotomous Variable = 1 if BMI in the overweight range (obese or overweight)	0.575	0.494
Home Food Price	Real food at home price in respondent's state in 1984 dollars	1.207	0.110
Away Food Price	Real food away price in respondent's state in 1984 dollars	2.159	0.143
Real Nutrition-Education Funding	SNAP-ed funds in 1984 dollars in millions (Averaged over all states and years)	1.591	4.657
Age	The respondent's age at the time of the survey.	47.845	15.547
Male	The respondent is a male.	0.421	0.494
White	Dichotomous Variable = 1 if the respondent is White but not Hispanic	0.811	0.391
Black	Dichotomous Variable = 1 if the respondent is Black but not Hispanic	0.082	0.274
Hispanic	Dichotomous Variable = 1 if the respondent is Hispanic	0.058	0.234
Married	Dichotomous Variable = 1 if the respondent is married	0.553	0.497
Divorced	Dichotomous Variable = 1 if the respondent is divorced	0.142	0.349
Widowed	Dichotomous Variable = 1 if the respondent is widowed	0.101	0.301
High School	Dichotomous Variable = 1 if the respondent exactly 12 years of school	0.299	0.458
Some College or more	Dichotomous Variable = 1 if the respondent completed at least 1 year of higher education/vocational school	0.574	0.494
Employed	Dichotomous Variable = 1 if the respondent is employed	0.632	0.482
$20,000 < Income <= $25,000	Dichotomous Variable = 1 if respondent's income is $20,000 - $25,000	0.087	0.281
$25,000 < Income <= $30,000	Dichotomous Variable = 1 if respondent's income is $25,000 - $30,000	0.106	0.308
$30,000 < Income <= $35,000	Dichotomous Variable = 1 if respondent's income is $30,000 - $35,000	0.155	0.362
$35,000 < Income <= $50,000	Dichotomous Variable = 1 if respondent's income is $35,000 - $50,000	0.181	0.385
$50,000 < Income <= $75,000	Dichotomous Variable = 1 if respondent's income is $50,000 - $75,000	0.191	0.393
Income > $75,000	Dichotomous Variable = 1 if respondent's income is greater than $75,000	0.143	0.350
Real Income	Real income in 1984 dollars, taken from the midpoint of the income categories in thousands (reported above)	19.225	10.694

4.2 Data on USDA Funding

State expenditures on nutrition education are measured by federal funds annually allocated to each state's CES office to allocate to the nutrition education program. As previously noted, these funds represent the federal match to the public non-federal funds allocated to the states. Because the dollar for dollar match that requires states to take the initiative to secure the funds, it likely reflects the state's interest and engagement in nutrition education and is associated with endogeneity at the state-level. To the extent that unobserved determinants of state interest in providing nutrition education are correlated with unobserved individual traits that influence food choice and weight, the endogeneity represents a potential source of bias in estimation of the effect of expenditures on weight outcomes. For this reason, I impose identifying restrictions, which are described later, on the estimated models in order to obtain causal estimates of the relationship between educational funds, BMI and the probabilities of overweight and obesity.

Figure 3: Total Real Nutrition Education Program Funding per Year ($/100 million)



In 1992, only 7 states were approved for a total of $661,076 in federal funding.[6] In 2000, the number of states receiving funding increased to all states except Delaware, Maryland and Alaska, for a total of $247,024,645. Expenditures are deflated by the CPI to reflect 1984 dollars. The nominal state-level funding is publicly available from the USDA. This data reflect both participation and amount of funding. The trend in the average state-level real nutrition-

[6] In 1992, Minnesota, Wisconsin, Ohio, New Hampshire, New York, Oklahoma, and Washington were the only states to receive funding. The probability of receiving funding is uncorrelated with state-level BMI trends and BMI levels.

education funding by year is depicted in Figure 3.[7] The growth in nutrition-education funding has increased substantially from 1992-2006.

4.3 Price Data

An additional policy variable of interest is food price. Given the analytical model with individual weight as the outcome is, in effect, a reduced-form weight or health production function, the model must include a measure of input prices (i.e., food prices). Models use state-level food price indices, classified by whether food is purchased for preparation and consumption at home (home food price) or purchased away from home and already prepared (away food price). Price data is from the ACCRA Cost of Living Index, which is published quarterly by the American Chamber of Commerce Research Association (ACCRA) for 250-300 urban centers. The index is widely used by economists, researchers and corporations to measure relative cost of living. Quarterly state-specific population-weighted city prices in a given year were averaged to get annual prices.

The state-level home food price index is calculated as a population weighted average of the nominal prices for all items included in the home food index for each urban area in a state. The away food price is created similarly. When calculating the away food price and home food price, only food items that are available in the ACCRA COLI consistently from 1992-2006 are included.[8] Food prices are deflated by the CPI to 1984 prices (real home food price and real away food price). The averages for the real home food price and the real away food price are provided in Table 3.

4.4 Empirical Models

[7] For simplicity, I will refer to real nutrition-education funding as simply nutrition-education funding in the text.
[8] Therefore, items such as tomatoes are excluded from the home food price calculation.

In order to estimate the effect of food prices and nutrition-education funding on the weight outcomes, we closely follow the methodologies that estimate the effect of other prices, as well as educational campaigns funding on outcomes. Tobacco consumption and its response to changes in price and anti-smoking campaign funding has been modeled in the past. Examples include Chaloupka and Warner (2000), which provides an extensive review of the cigarette price and tax literature, and Farrelly et al. (2002), which examines the anti-smoking campaign literature.

Linear probability models are used to estimate the effects of nutrition education funding on two individual-level binary indicator variables: overweight and obese. For the continuous outcome, BMI, a linear model is used. As a baseline, the following estimating equation is offered,

$$(1)\quad Y_{\mathrm{ist}}=\beta_0+\beta_1 X_{\mathrm{ist}}+\beta_2(\textit{Real Nutrition Education Funding})_{\mathrm{st}}+\beta_3(\textit{Real Away Food Price})_{\mathrm{st}}+\beta_4(\textit{Real Home Food Price})_{\mathrm{st}}+\beta_5 \textit{State}+\beta_6 \textit{Year}+\varepsilon_{\mathrm{ist}}$$

Where *i* indexes the individual, *s* indexes the state, and *t* indexes the year. Y_{ist} is one of two individual-level indicators for the binary outcomes of having a BMI in the overweight or obese range. For the continuous model, Y_{ist} is the individual-level BMI (BMI). X_{ist} is a vector of individual demographic characteristics, including dummies for male, white, black, Hispanic, high-school graduate, some college or more, age and age squared, and a continuous variable for real income. *Real Away Food Price* and *Real Home Food Price* are the state and year specific real price indices for Food Away Price and Food Home Price. *State* is a vector of state dummies, and *Year* is a vector of year dummies. Again, β_2, β_3, and β_4 are the coefficients of interest. Identification of the parameters of interest in equation (1) is achieved by within state variation in funding over time relative to state that does not experience changes in funding over time.

This identification strategy fails to control for state-specific unobserved characteristics that may vary over time and impact weight outcomes, nutrition-education funding levels and prices. To address this limitation, Gruber and Frakes (2006) suggest improving equation (1) by adding controls for state-specific linear time trends.

$$(2)\ Y_{ist}=\beta_0+\beta_1 X_{ist}+\beta_2(\textit{Real Nutrition Education Funding})_{st}+\beta_3(\textit{Real Away Food Price})_{st}+\beta_4(\textit{Real Home Food Price})_{st}+\beta_5 \textit{State}+\beta_6 \textit{Year}+\beta_7\ \textit{State x Time}+\varepsilon_{ist}.$$

A model described by equation (2) is more accurate if nutrition-education expenditures are endogenous. A model with fixed state effects and year effects will not capture all potential state-level causal responses to nutrition education. For instance, as states change funding levels in response to local economic conditions, BMI within the state could also change. Equation (2) includes state-specific linear time trends to ensure only the estimated real spending on nutrition-education and price effect reflects exogenous policy changes rather than a combination of the effects of spending, price policy changes and some unmeasured state characteristics, (e.g. trends in nutrition awareness or social norms within a state that differ across states and over time). This identification strategy uses the variation in implementation of nutrition-education programs across the country to control for unobservable factors for changes in these influences over time.

To address any unobserved social norms regarding physical health impact funding, prices and weight outcomes, I estimate a specification that includes a 1 year lagged value of the state average BMI. Finally, as a falsification test, I estimate the impact of nutrition-education funding on the probability that the individual wears a bicycle helmet.

The data definitions, means, and standard deviations of all individual-level and state-level variables were discussed previously in the data section and reported in Table 3. The statistics are based on a sample of 2,252,664 individuals. Finally, in all regressions the BRFSS survey weights and the standard errors are corrected for heteroskedasticity and clustering within states.

5. **Results and Discussion**

All results presented in this section are generated from the regressions described in equations (1) and (2) above. Results describe the influence of both the real nutrition-education program funding and real food prices on BMI, as well as probabilities of overweight and obesity. Because these models are linear probability models, the presented regression coefficients are marginal effects and the standard errors are corrected for heteroskedasticity and clustering at the state-level.

Table 4 provides a baseline assessment of federal nutrition spending and price effect from estimation of equation (1). In addition, Table 4 includes the results of equation (1) omitting the real food prices. Results in Table 4 suggest that inclusion of real food prices has very little effect on the size of the marginal effect of nutrition education spending. In addition, the results suggest that nutrition-education spending (on average) has the intended marginal effect on individual level BMI, but not on probability of overweight or obesity. The size of the effect is quite small, however, implying that a $1 million increase in expenditures will decrease individual BMI by 0.0017 kg/m^2. For the average 45 year old male, at a height of 5 feet, 9 inches (1.75 meters) and weight of 180 lbs (81.81 kg), this would be a 0.01915 lb (0.008686 kg) loss. This model does not control for state-specific linear time trends.

Therefore, the results may be biased by unobserved state- and individual-level traits that vary over time.

Table 4: State Fixed and Year Fixed Effects

	(1)		(2)		(3)	
	BMI	BMI	Obese	Obese	Overweight	Overweight
Real Nutrition-Education Funds (in millions)	-0.0021 (0.0007)a	-0.0017 (0.0009)c	0.0003 (0.0002)b	0.0004 (0.0002)b	0.0007 (0.0002)a	0.0007 (0.0002)a
Real Home Food Price	-	-0.1148 (0.1938)	-	-0.0115 (0.0224)	-	-0.0171 (0.0303)
Real Away Food Price	-	-0.0064 (0.1365)	-	0.0043 (0.0182)	-	0.0065 (0.0268)
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
N	2,262,952	2,262,952	2,262,952	2,262,952	2,262,952	2,262,952

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c =$p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables include age, age squared, gender, education level, real income, marital status and employment status.

Table 5 presents the results of specification (2), the estimating equation that adds a state-specific time trend. As shown, the estimated relationship between real nutrition-education funding and all individual-level outcomes is positive. Interestingly, the effect of price policy is larger in magnitude than the estimated expenditure effects and is statistically significant for BMI.

Table 5: Real Education Funds Vs. Real Food At Home and Real Food Away from Home Prices

Variable	BMI	Obese	Overweight
Real Nutrition-Education Funds (in millions)	0.0017 (0.0029)	0.0003 (0.0002)	0.0003 (0.0003)
Real Home Food Price	0.3265 (0.1576)b	0.0139 (0.0120)	0.0121 (0.0142)
Real Away Food Price	-0.0987 (0.0935)	-0.0078 (0.0071)	-0.0111 (0.0084)
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
State Time Trend-Linear	Yes	Yes	Yes
N	2,262,952	2,262,952	2,262,952

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c =$p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables include age, age squared, gender, education level, real income, martial status and employment status.

The positive relation between real spending on nutrition-education programs and the weight outcomes as described in Table 5 is troubling and suggests that models controlling for unobservable changes in the state-specific trends in attitudes about nutrition or trends in combating obesity may still may be imprecisely estimating the *average* impact of real funding for nutrition-education programs and/or price policy. For instance, the results in Table 5 suggest that reverse causality may be a source of bias. Perhaps, states with higher BMI are allocated more federal funding or are more aggressive in obtaining funding to combat obesity. If true, then state-specific time trends cannot control for such influence. Given a potential reverse causality problem and the dynamics of weight, using a lagged measure of state-specific real nutrition education funding and prices may be more appropriate when estimating the impact on individual-level measure of BMI, obesity and overweight.

Table 6 illustrates the effect of real nutrition-education funding and real food prices when one and two period lags are used for real funding for nutrition-education programs, real home food price and real away food price. In these models, an interesting change is illustrated. While controlling for both state-specific linear and quadratic time trends, neither a one nor two-period measure of lagged funding shows a significant impact on BMI, obesity or overweight. However, in the two-period model, the impact of the real price of food purchased for home consumption has a negative and significant effect on all individual-level outcome measures. This suggests real nutrition-education program funding may be less effective than targeted price policy. Over at least a two period lag, the results suggest increasing food prices may reduce individual food demand to a level consistent with weight stabilization rather than weight gain.

Table 6: Lagged Real Education Funds with Linear and Quadratic Time Trends

	(1)		(2)		(3)	
	BMI	BMI	Obese	Obese	Overweight	Overweight
Real Nutrition-Education Funds	0.0865	0.0713	0.0056	0.0047	0.0070	0.0053
(in millions)	(0.0760)	(0.0766)	(0.0051)	(0.0052)	(0.0058)	(0.0057)
Real Home Food Price	-0.4750	-1.1129	-0.0450	-0.0901	-0.0550	-0.0844
	(0.4347)	(0.4804)b	(0.0319)	(0.0343)b	(0.0352)	(0.0419)b
Real Away Food Price	-0.7426	-0.3488	-0.0518	-0.0212	-0.0624	-0.0359

	(0.5235)	(0.4449)	(0.0348)	(0.0299)	(0.0394)	(0.0334)
Period Lag	One	Two	One	Two	One	Two
State Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
State Time Trend– Linear	Yes	Yes	Yes	Yes	Yes	Yes
N	2,181,481	2,095,115	2,181,481	2,095,115	2,181,481	2,095,115

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c =$p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables included are age, age squared, gender, education level, real income, martial and employment status.

Another possibility that derives from the lagged nature of intake and weight change is that the stock of information about nutrition and calorie balance is more important than the period-specific flow of information. Table 7 demonstrates the cumulative impact of real nutrition education funding. As demonstrated, the impact across all three weight outcome measures is negative. There is a statistically significant and negative impact of cumulative real nutrition-education funding on BMI. While the impact on obese and overweight is negative, neither coefficient is statistically significant. This result suggests, the stock of state-level investment in real nutrition-education information has more power than the annual investment.

Table 7: Cumulative Real Education Funds with Linear Time Trends

	(1)	(2)	(3)
	BMI	Obese	Overweight
Cumulative Real Nutrition-Education Funds	-0.0005	-0.0000	-0.0000
(in millions)	(0.0003)c	(0.0000)	(0.0000)
Real Home Food Price	0.3418	0.0150	0.0136
	(0.2180)	(0.0161)	(0.0181)
Real Away Food Price	-0.0914	-0.0073	-0.0105
	(0.1076)	(0.0088)	(0.0103)
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
State Time Trend– Linear	Yes	Yes	Yes
N	2,262,952	2,262,952	2,262,952

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c =$p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables included are age, age squared, gender, education level, real income, martial and employment status.

Finally, real education funding and price policies could possibly have differential effects based on income and education level. The effects illustrated in Table 5 are estimates of the *average* effect for all income groups. Therefore, Table 8 considers the interactive effect of real nutrition education policy and price policy by income level. To create the interaction terms, the following income categories provided by the BRFSS were used: less than $25,000/year; between $25,000 and $50,000/year; and over $50,000/year. The three categories were interacted with real nutrition-education funding and the real food price indices. Results indicate that the impact of real nutrition-education funding and price policy varies by level of real income.

From Table 8, the interaction effects allow us to identify the appropriate effect of real nutrition-education funding for the highest income groups. In fact, only the BMI and prevalence of obesity among the middle income group is significantly impacted by the level of real nutrition-education funding. Table 8 also describes the differential effects of real food prices by income group for the weight outcomes. The real food away price has the intended and significant effect on the lowest income group. In comparison, the weight outcomes for the highest income groups are positively, but insignificantly, influenced by increases in the real price of food purchased for away from home consumption (real away food price). The real price of food purchased for at-home consumption (real home food price), has an interesting impact on one weight outcome: obese. For the highest income group, the real home food price has a negative and significant impact on the probability of being obese.

Table 8: Real Education Funds by Income Level with Linear Time Trends

	BMI	Obese	Overweight
Real Nutrition-Education Funds * Income $0_25 Thousand	0.0031	0.0004	0.0004
	(0.0029)	(0.0002)	(0.0003)
Real Nutrition-Education Funds * Income $25 – 50 Thousand	-0.0077	-0.0004	-0.0002
	(0.0031)b	(0.0002)c	(0.0003)
Real Nutrition-Education Funds * Income $50 Thousand +	-0.2371	-0.0271	-0.0156
	(0.2159)	(0.0165)	(0.0194)
Real Home Price * Income $0_25 Thousand	0.4101	0.0183	0.0201
	(0.1596)b	(0.0122)	(0.0144)
Real Home Price * Income $25 – 50 Thousand	-0.2679	-0.0208	-0.0295

	BMI	Obese	Overweight
	(0.1729)	(0.0132)	(0.0156)c
Real Home Price * Income $50 Thousand +	-0.6887	-0.0868	-0.0667
	(0.6873)	(0.0525)c	(0.0618)
Real Away Price * Income $0_25 Thousand	-0.3381	-0.0223	-0.0238
	(0.0951)a	(0.0073)a	(0.0086)a
Real Away Price * Income $25 – 50 Thousand	0.6781	0.0391	0.0307
	(0.1071)a	(0.0082)a	(0.0096)a
Real Away Price * Income $50 Thousand +	0.4411	0.0603	0.0139
	(0.4000)	(0.0306)b	(0.0360)
Income $25 – 50 Thousand	-2.3588	-0.1478	-0.1225
	(0.1360)a	(0.0104)a	(0.0122)a
Income $50 Thousand +	-1.1395	-0.1038	-0.0380
	(0.8539)	(0.0652)	(0.0768)
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
State Time Trend– Linear	Yes	Yes	Yes
N	2,262,952	2,262,952	2,262,952

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c =$p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables included are age, age squared, gender, education level, real income, martial and employment status.

Another useful analysis is determining the impact of nutrition education funding by education level. Table 9 considers the interactive effect of real nutrition education policy and price policy by education level. To create the interaction terms, the BRFSS used the following categories: less than a high-school education (less than high school); only a high school degree (high school); and some college or more (some college). The three categories were interacted with real nutrition-education funding and the real food price indices. The results are qualitatively the same as the income effect. As expected, the effect of nutrition-education funding has a larger impact on the higher educated group. Additionally, the same qualitative effects result for the interaction of education level and real food prices as estimated for the interaction of income level and real food prices. Thus, describing the same differential effects of price policy and education policy. These results suggest the lowest income and education levels price policies, although regressive, have a larger and more significant impact on weight outcomes relative to funding nutrition education programs.

Table 9: Real Education Funds by Education Level with Linear Time Trends

	BMI	Obese	Overweight

Real Nutrition-Education Funds * Less Than High School	0.0082 (0.0031)b	0.0007 (0.0002)a	0.0011 (0.0002)a
Real Education Funds * High School	-0.0055 (0.0018)a	-0.0003 (0.0001)b	-0.0007 (0.0002)a
Real Education Funds * Some College	-0.0072 (0.0043)c	-0.0005 (0.0003)c	-0.0009 (0.0003)a
Real Home Price * Less Than High School	0.9972 (0.3217)a	0.0486 (0.0231)b	0.0453 (0.0284)
Real Home Price * High School	0.2295 (0.2717)	0.0193 (0.0171)	0.0344 (0.0239)
Real Home Price * Some College	-1.2538 (0.3461)a	-0.0675 (0.0215)a	-0.0759 (0.0328)b
Real Away Price * Less Than High School	-0.3129 (0.1781)c	-0.0250 (0.0116)b	0.0025 (0.0167)
Real Away Price * High School	-0.0159 (0.1620)	0.0003 (0.0085)	-0.0304 (0.0157)c
Real Away Price * Some College	0.3835 (0.2136)c	0.0298 (0.0124)b	-0.0071 (0.0216)
High School	-0.5054 (0.3567)	-0.0472 (0.0215)b	0.0212 (0.0348)
Some College Plus	-0.1295 (0.5807)	-0.0408 (0.0320)	0.0566 (0.0617)
State Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
State Time Trend– Linear	Yes	Yes	Yes
N	2,262,952	2,262,952	2,262,952

Heteroskedasticity corrected standard errors that are adjusted for state-level clustering appear in the parentheses, c $=p < 0.10$, b= $p < 0.05$, a= $p < 0.01$. Additional variables included are age, age squared, gender, education level, real income, martial and employment status.

6. **Conclusion**

The estimates contained in the previously reported tables suggest the nutrition-education funding is having less success than intended. As reported above, cumulative and lagged effects of real nutrition-education funding show some evidence of a larger impact on some measures of weight than the impact of contemporaneous funding. In addition, individuals from some income groups and education levels are more responsive to price and real nutrition-education funding than others, although the significant effects are quite small.

These results are consistent with previous work that suggests lower income, less well-educated individuals are more responsive to price whereas higher income, better educated individuals will be more responsive to information. For lower income groups, regressive real price increases for food prepared away from home has the intended but perhaps not the desired regressive impacts. Also, for individuals with incomes in the range of $25,000 to $50,000 / per year, BMI and probability of being obese appear to respond to changes in real nutrition-education funding.

An important note is the estimated impacts of *all* of the evaluated policies were small. In addition, some evidence suggests that education policy is less effective relative to price policy. This research takes advantage of already existing data to provide a useful analysis. Further research could offer an investigation of the mechanisms by which states obtain and implement nutrition education programs, as well as if different types of programs produce better results than others. This line of research will continue as these data become available.

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