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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

We provide the first comprehensive assessment of the effects of state-level nutrition-education program funding on individual-level BMI, the probability of obesity and the probability of above normal weight. We estimate models using pooled cross-sectional data from the Centers for Disease Control's (CDC) Behavioral Risk Factor Surveillance System (BRFSS) and data from 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 $0 to nearly $248 million. We isolate the effect of nutrition-education funding while controlling for demographics, state and year fixed effects. Our results suggest that nutrition-education program funding is associated with reductions in BMI and the probability of an individual having an above normal BMI. Furthermore, we find evidence that the nutrition-education program funding is a complement to education, individuals with a higher level of education will have a larger response to funding than those with lower levels of education.

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1. Introduction

Body Mass Index, BMI, is measured as weight in kilograms divided by height in meters squared (kg/m^2). The average BMI in the US has been increasing and more Americans are being classified as overweight (BMI over 25 kg/m^2) and obese (BMI over 30). The rise in the number of individuals who are overweight, in recent decades has been well documented. A substantial amount of research investigates potential reasons for this increase. Despite the breadth of research one hypothesis prevails, the increase in average BMI is the result of economic changes that have altered the lifestyle choices of Americans (Philipson, 2001; Lakdawalla and Philipson, 2002; Gomis-Porqueras and Perlata-Alva, 2008; Cawley,1999; Cutler, Glaeser and Shapiro, 2003; Chou, Grossman and Saffer, 2004).

In addition to the research mentioned previously, other literature explains the increase in the average BMI as it relates to 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 other non-food items, for instance, soda prices (Frisvold, Fletcher, Neff, 2008) and cigarette prices (Cawley, Markowitz, Taurus, 2004). The foundation of these explanations is technological change. If reversing the trend in the average BMI requires overturning its causal roots, this strategy is unappealing due to the importance of technological change in economic growth and increases in welfare. Therefore, other effective policies must be identified. While measuring a change in knowledge of healthy-living practices is difficult, and may not explain the trend in BMI, promoting health-living and better nutrition nationwide may be a plausible solution to reversing the trend. Despite the wealth of data becoming available on nutrition-education programs, there is little *economic* research that relates nutrition-education programs to BMI.

This paper uses micro-level data from the 1992-2006 Behavioral Risk Factor Surveillance System (BRFSS). We augment the BRFSS with federal funding for nutrition-education programs. The federal funding is allocated to each state at different years and rates. Furthermore, each state is responsible for using the allocation to fund nutrition-education programs throughout the state. Our main results are 1) the nutrition-education program funding reduces individual-level BMI and 2) the probability of being overweight, BMI ≥ 25 kg/m^2, over this time frame. The findings control for individual-level measures of age, race, household income, years of schooling completed, marital status, as well as state and year fixed-effects.

2. Background

The literature in the area of obesity has been growing rapidly since the mid-1990's. The relevance of the research is well documented by the literature on the 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).

The economic impact of obesity has also gained interest. The earliest study of the economic impact of obesity was Wolf and Colditz, 1998. This study finds that in 1995 the economic costs of obesity were US$99.2 billion. More recently a study estimates that medical spending on obesity has ranged from US$26.8 using data from the Medical Expenditure Panel Survey (MEPS) to US$47.5 billion dollars using the National Health Accounts (NHA) (Finkelstein, Fiebelkorn and Wang, 2003). Table 1 illustrates that in 1998 nearly 50% of the obesity related costs were publically financed. The public funding of overweight and obesity rivals the amount of public funding associated with smoking (National Center for Tobacco Free Kids, 2002).

The trends in prevalence for overweight in persons 18 years of age and older are presented in Table 2. The increase in overweight and obesity between NHANESII and NHANESIII is the source of considerable concern. Table 2 illustrates the reason for the concern since the increase in obese from NHANESIII (1988 – 1994) to NHANES (2003 - 2004) is approximately a 42% increase. Over the same time period, the increase in the prevalence of overweight has been about 18%.

Data from the Behavioral Risk Factor Surveillance Survey (BRFSS) describe a similar situation. As presented in Figure 1, the average BMI for the US population has increased from 1995–2006. [3] The persistence in the trend is interesting as it has continued even after the problems associated with increasing BMI and obesity have been identified. Not only have they been identified, it would appear that they have been accepted by the US population, as the growth of industries aimed at reducing BMI have grown over this same time period. According to the US Food and Drug Administration

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

(FDA), an estimated $30 billion was spent in the United States in 1992 on all types of diet programs and products, including diet foods and drinks (Center for Nutrition Policy and Promotion (CNPP) website, http://www.cnnp.usda.gov, accessed March 10, 2009).

As described previously, the current focus of the economic literature on obesity describes why this BMI trend has developed. While the theme in the literature describes how economic changes have influenced decision making resulting in a sustained increase in calorie consumption over calorie expenditure, the literature varies in the explanation for this imbalance. Therefore, at this point, we offer more details from the aforementioned studies. Some have focused on the reduction in physical demands of labor as an explanation, Philipson (2001) and Lakdawalla and Philipson (2002). Other authors have studied the shift towards higher calorie food as a result of relative prices of higher calorie to lower calorie food (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; Frisvold, Fletcher, Neff, 2008; Rashad, Grossman, Chou, 2006). Further study has investigated the influence of non-food items, for instance cigarette prices, to determine the influence on calorie consumption and BMI (Cawley, Markowitz, Taurus, 2004). While the extant research has found reasonable and plausible explanations for the increase in obesity, little explanation has been offered regarding effective means to reverse this trend without changing prices, a potentially regressive tax.

Despite the wealth of studies focusing on price policies, perhaps education polices could be a successful means to reduce individual-level BMI. Recent economic literature has found that spending on education programs can be a successful means to induce 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). While the economic literature is sparse, other fields find that nutrition-educational programs have been effective in reducing the risk of chronic diseases such as heart disease, diabetes, and obesity (Lasker et al., 2008; Dansinger, 2005). In addition, micro-level research has determined the effectiveness of nutrition-education programs in very specialized settings (Connelly, et al.; 2007; Clifford, et al.; 2009, Byrd-Williams, et al.; 2009). Therefore, it is important to determine if continued funding of nutrition-education programs is an effective means to reduce the prevalence of overweight and, more specifically, obesity in the US.

Time is of the essence, as Table 1 suggests publically-funded health-insurance programs support a large portion of the economic costs associated with obesity in the US. In addition, the USDA has experienced growth in obesity among participants in its Supplemental Nutrition Assistance Programs (SNAP). In response to this growth, the USDA commenced a program called the Supplemental Nutrition Assistance Program - Nutrition Education (SNAP-ed) in 1992. SNAP-ed is designed to increase nutritional understanding and promote healthy-lifestyle awareness. Although SNAP-ed is a federally funded program it is administered by each state through partnerships between a state's department of health and land-grant university. The funds are distributed to the states based on grant applications submitted by the state partners to the USDA. Each state uses the grant awards to fund multiple forms of educational interventions, such as nutrition-education programs within public-school systems, public-health clinics, as well as public-service announcements and advertisements. Further discussion of SNAP-ed appears in later sections of this paper.

Using the data on nutrition-education program funding that has been allocated to states by the USDA, our paper provides a different perspective from the recent research. We determine the impact of the nutrition-education program funds that the USDA has allocated to each state on individual-level BMI, obese and overweight. This approach is novel since the recent literature on obesity has largely focused on prices. The next section describes our analytical model. Subsequently, we describe our data and empirical model. Sections five and six present and discuss the results in the context of the rising economic costs of overweight and obesity.

3. Analytical Framework

Any behavioral model describing the growth in obesity using economic, or other, tools should describe the same underlying function. At the micro-level, the growth in BMI is a function of an energy balance equation. The energy balance equation is, quite simply, 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. Potentially, if the trend in BMI persists it could rise above the threshold of overweight or, in the extreme, obesity. To counteract the growth in an individual's BMI, the imbalance needs to be reversed. There are constraints that impede an individual's ability to reverse the energy imbalance and reduce their BMI. Some of the constraints are exogenous, such as age, genetics, race, ethnicity and gender, while others, such as knowledge and prices may be influenced by policy.

As the Grossman health production framework describes, individuals gain utility from health (Grossman, 1972). Keeping with this framework, an individual will gain utility from producing a healthy weight and disutility from producing a BMI that is outside of the healthy (normal) range, 18 $kg/m^2 \leq$ BMI < 25 kg/m^2. Therefore, it follows that production of a BMI outside the normal range is more than likely a byproduct of another production process (Chou, et. al, 2004; Philipson and Posner, 1999; Gomis-Porqueras and Perlata-Alva, 2008). Philipson and Posner (1999) posits the increase in the prevalence of obesity has arisen as a result of the increase in technological change and increase in sedentary lifestyles. Chou, Grossman and Saffer, (2004) and Porqueras and Alva (2008) describe the rise in obesity as a by-product of the household-production function as described by Becker (1965).

Using Becker's framework, as is consistent with the literature, we can describe the production of an undesirable BMI as a by-product of household production (Chou, et. al, 2004; Porqueras and Alva, 2008). As household production responds to price changes and investments in education, so will the production of the by-product. Theoretically, to combat the rise in BMI policy makers could seek to increase the efficiency in household production. By increasing the efficiency of production, both health production and household production, we should see a reduction in the production of by-products such as increases in BMI. Economics has shown that on-the-job training and on-the-job learning increase the efficiency of production. Training and educational programs that have a targeted purpose, to increase the production of health could reduce BMI and reduce the probability of an individual being overweight or obese.

Consider that BMI is a function of several inputs, including education. Better information about how to produce health and as a result, BMI, would function as a productivity shifter as suggested by Grossman (1972). This reduced form can be described by the following:

$$\text{BMI} = f\,(\textit{input prices};\ \textit{education})$$

Strictly speaking, the prices of inputs do not enter a production function directly. However, the input-demand functions contain prices. Thus, substitution of the factor-demand functions into the production function introduces the input prices and we are able to estimate this reduced form. However, given the constraints on behavior modification, policies may not be successful in practice. Therefore, to determine the outcome of a nutrition-education program we must develop an empirical model.

4. Data Description and Empirical Implementation

To investigate the impact of the nutrition-education program funding on an individual we select three individual-level outcomes: BMI, an indicator variable describing if the individual's BMI is above the normal range, where BMI ≥ 25 kg/m^2, (overweight) and an indicator variable describing that an individual's BMI-level is in the obese range, BMI ≥ 30 kg/m^2, (obese). The individual-level variables are from repeated cross-sections, 1992-2006, of the Behavioral Risk Factor Surveillance System (BRFSS). The BRFSS is an annual telephone survey of persons 18 years and older. It is conducted by state health departments and administered by the Centers for Disease Control and Prevention (CDC). The CDC uses the information contained in the BRFSS by year to make 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 in 1996 all 50 states plus the District of Columbia, Guam and the U.S. Virgin Islands participated in the survey. Over this time frame, respondent participation also rose; the 1992 BRFSS includes 96,213 while the 2006 BRFSS includes 355,216 individuals. Our final analysis sample for pooled cross-section from 1992-2006 includes, 2, 262,952 individuals.[4] As described previously, Figure 1 shows the growth in the national level BMI from 1992-2006. During this time period BMI increased by 2.10 kg/m^2 or approximately 7%.

Figure 2, describes an additional concern, nationwide the US has experienced a continued increase in the prevalence of an overweight (BMI ≥ 25 kg/m^2). By focusing on overweight we are able to illustrate a more accurate picture of the "fattening" of the US population. Over our time-frame, the prevalence of overweight increased from 1992 to 2006, by nearly 35%.

Our analytical model suggests that we augment the individual-level BRFSS data with state-level data on inputs prices. Therefore, we augment the BRFSS data with state-level food price; we further classify food as food-away-from-home (away food) and food-at-home (home food). The price data come from the ACCRA Cost of Living Index which is published quarterly by the American Chamber of Commerce Researcher Association (ACCRA), for between 250 and 300 urban centers. The index is widely used by economists, researchers and corporations to measure relative cost of living. We averaged the quarterly state-specific population weighted prices of the city prices over the four quarters in a given year to get annual prices. The state-level home food price is

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

calculated as the population weighted average of the nominal prices for the home food included items for each urban area in a state. The away food price is created similarly. When calculating the away food price and home food price we only include food items that are available in the ACCRA COLI consistently from 1992-2006.[5] Additionally, we deflate these prices 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 in Table 3. However, there is not enough within state variation between 1992 and 2006 in real food prices to independently identify the effect of real price and state-fixed effects. Given the importance of state-fixed effects to the analysis of the nutritional-education allocated to each state, the state-level food prices will be omitted from further analyses in this paper.

In addition, our paper measures the USDA's funding of nutrition-education programs at the state-level.[6] In 1992, the USDA began its SNAP-ed program. Through the SNAP-ed program the USDA made a pool of money available to states who were willing to apply for grants to the SNAP-ed fund. States could then apply to the SNAP-ed fund to develop state-level programs that would increase nutrition-education and promote healthy-lifestyle awareness. Therefore, while SNAP-ed is a federally funded program, the program is administered at the state-level. In addition, for a state to receive funding, a partnership must be created between a state's department of health and the respective land – grant university. Hence, states receive funding a state-specific program only after a grant is submitted and, subsequently, awarded to the state's department of health –

[5] Therefore, items such as tomatoes are excluded from the home food price calculation.
[6] The data in this paper span from 1992 to 2006, there are more years available for BRFSS (2006 & 2007), ACCRA COLI (2006-2008) and SNAP-ed (2006-2008). However, since the earlier years of the BFRSS include fewer observations, we would have had to cut relatively more of the earlier of BRFSS data to keep our overall analysis to under the technically demanding 2.2 million observations.

university partnership. The state-level programs support a variety of interventions including within public-health clinics, public service announcements and public-school systems. In 1992, only 7 states were approved for a total of $661,076 in federal funding.[7] In 2000, the number of states receiving funding increased to all states except Delaware, Maryland and Alaska, for a total of $247,024,645. We deflate the data on state-level nutrition-education funding by the CPI to report in 1984 dollars. The nominal state-level funding is publically available from the USDA and the average level of real nutrition-education funding per state over the 15 year period is reported in Table 3.

The trend in the average state-level real nutrition-education funding by year is depicted in Figure 3.[8] Taken along with Figure 1, the growth in nutrition-education funding outpaced the growth in BMI. The increase in nutrition-education funding that occurs in 2000 is due to the increase in the number of states receiving funding this year. Estimation of the effects of nutrition-education funding proceeds by probit models for the two binary outcome variables, overweight and obese. For the continuous outcome, BMI-level the results are achieved via an OLS regression. In general, we can describe the estimating equation as follows:

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

Here, Y_{ist} is an individual-level indicator 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:

[7] 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.

[8] For simplicity, we will refer to real nutrition-education funding as simply nutrition-education funding in the text.

male, white, black, Hispanic, high-school graduate, some college or more, age and age squared. *State* is a vector of state dummies, and *Year* is a vector of year dummies. Again, β_2 is the coefficient of interest. Note that in our models the nutrition education funding coefficients are estimated from the within state variation in nutrition-education funding over time.

The data definitions, means, and standard deviations of all the other variables included in the regressions are reported in Table 3. The sample statistics are based on a sample of 2,252,664 individuals. Some discussion of the variables described in table 3, but not discussed in the analytical section, is warranted here. We expect that the effect of income could be either positive or negative. It could be positive if those with higher incomes have more time constraints which may lead to less time to exercise and less time to prepare lower calorie meals. On the other hand, those with higher incomes could have a lower discount rate and, accordingly, a lower BMI. Education as measured by years of formal schooling completed may increase efficiency in the production of a variety of household commodities, expand knowledge concerning what constitutes a healthy diet, and signal that the individual is more future oriented. Any of these effects would reduce BMI. Marital status, in general, tends to be associated with increases in health. However, empirically it can be associated with increases in BMI as the energy balance equation for a married individual is, on average, positive.

Recall that the main goal of the current research is to determine if nutrition-education programs can be an effective means to lower BMI, thereby reducing the probability of having a BMI in the overweight range or having a BMI in the obese range. A conservative interpretation of our results would suggest that our estimates are not causal. Nevertheless, our results will explain and identify policies that have an important influence on the trend in BMI and obesity.

5. Results

Table 4 presents the results of our models for BMI, overweight and obese, given the BRFSS sub-sample described by Table 3. The presented results control for the variables listed in Table 3 and are found from estimation of equation (1). The results for the column BMI are obtained via an OLS model and the results for the overweight and obese columns are obtained via probit regressions. All three models are estimated with clustered standard errors, include both state and year fixed-effects.[9] Finally, the presented results represent the marginal effects.

The most important result is nutrition-education program funds are associated with a decrease in 1) the individual-level BMI and 2) the individual-level probability of overweight. Table 4 also presents the results of the other independent variables. The effects of individual-level characteristics on the level of BMI, for the most part, have the expected sign and significance. Age is associated with increases the individual-level BMI. Whites and blacks have a higher BMI relative to those reporting Asian and other race. Hispanic is associated with having a higher BMI compared to non-Hispanics. Being married or divorced is positively associated with BMI, overweight and obese. Widow-hood is negatively associated lower BMI levels, lower probability of being obese and positively associated with overweight. As suggested previously, higher levels of

[9] The sampling weights are not employed in the regression estimates. DuMouchel and Duncan (1981) and Maddala (1983, pp. 171-173) have shown that in the case of exogeneous stratification, using the weights is not required.We find similar results when we compare weighted and unweighted regressions.

education and income are related to lower BMI levels and lower probabilities of being overweight or obese.

Further analyses are performed to determine if the effect of state-level nutrition-education varies by education or income.[10] Table 5 provides the summary statistics of the dependent variables stratified by education and income. To determine the variation by education-level, we interact the nutrition-education funding variable with the dichotomous variables that indicate completion of high-school (high-school) and some college or more (some college). From this analysis we are able to determine if the state-level nutrition-education programs are, on average, complements or substitutes to individual-level education. Complementarity is suggested if the coefficient on the interaction between college or more and nutrition-education funding is higher (in absolute value) than the coefficient on the interaction between high-school completion and nutritional educational-funding. The results of this analysis are found in Table 6.

Our results suggest that nutrition education funding and education-level are complements. As presented in Table 6, the outcome variables of BMI, overweight *and* obese are, on average, negatively and significantly associated with the interactions between state-level nutrition education funding and education-level. In addition, the interaction between state-level nutrition-education funding and high-school has a lower marginal effect than the interaction between nutrition-education funding and some college or more. Taken together, these results show the most responsive group to nutrition-education programs at the state-level is the highest educated cohort.

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[10] Table 4 includes a measure of real income, given the time aspect of the analysis this is the proper measure of income to include. However, at this point given that we are interested in stratifying by income-level the more appropriate measure is the nominal income-level.

Since income may constrain individuals we investigate the impact of nutrition-education funding by income. First, we stratified the data into three income categories, income up to $24,999, income from $25,000 – $49,999, income of $50,000 or more. For the data stratified by income, we created interaction terms between the nutrition-education funding and income-level. Table 7 illustrates that nutrition-education funding is associated with decreases in BMI for the highest income-level. In addition, in absolute value, as one would expect, the interaction between nutrition-education funding and the highest income-level has a larger impact on the probability of overweight than the interaction between nutrition-education funding and the lower levels of income. Table 7, also, describes an interesting pattern for the outcomes of overweight and obese. For obesity, the intended effect *is* achieved for the lowest income-level. Recall, the outcome of obese has been relatively immune to other policies. However our results show that nutrition-education funding is helpful to those in lower income levels. To summarize, those in the highest income groups are more responsive to nutrition-education funding when compared to lower income groups for the BMI and overweight outcomes. Also, as described, the probability of obesity is responsive to the nutrition-education funding for the lowest income-level, as intended.

At this point a word regarding the potential policy endogeneity. Consider the following concern (case 1); states with a higher prevalence of obese individuals will have a greater amount of funds allocated to them through the USDA's SNAP-ed program grant process. If this is the case, the coefficient on the nutrition-education funding presented in this paper should be considered an under-estimate of the true value (in absolute value). On the other hand case 2 could prevail where states with 1) a high degree of awareness of obesity problem among its residents *and* 2) a lower prevalence of obesity relative to the national average have more funds allocated to them through the USDA's SNAP-ed grant process. Case 2 is consistent with the estimated effect of the nutrition-education funding being an over-estimate of the true parameter value. To determine if endogeneity is present, as suggested by case 1 or case 2, we should include a lead of the nutrition-education funds as well as the current amount of nutrition-education funds as regressors in our equation (1). If the coefficient on the lead variable is significant this suggests that endogeneity is present since the future should not have a significant relationship with the current value of the outcome variable. The sign of the lead variable will determine if the endogeneity is consistent with either case 1 or case 2 as described. However, due to multicollinearity between the current value and lead of the policy variable it is difficult to test for policy endogeneity since the multicollinearity renders the policy and the lead of the policy insignificant.[11]

Overall, the results in this section suggest that the impact of the USDA's nutrition-education program may have been helpful since its inception in 1992.[12] In addition, our results suggest that nutrition-education funding will have a differential effect on individuals based on education. We find that individuals with lower education levels do not have the intended response to the nutrition-education funding their state was allocated while the higher-educated groups in the same state have a larger response to funding in absolute

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[11] We used lead of various lengths to try to minimize the multicolinearity problem.

[12] While, the argument can be made that our measure of nutrition-education funding may proxy for the state-level nutrition-education awareness, even if this is the case, our results are still of interest. If, at best, we are measuring state-level awareness than the interpretation of our results is as states increase their awareness of best nutrition practices, on average we will see a decline in 1) BMI and 2) the prevalence of individuals having a BMI in the overweight range.

value. In the next section, we develop the average elasticity of nutrition-education funding for each of our outcome variables.

6. Discussion and Conclusions

To investigate the impact of the nutrition-education funding variable further, we calculate the elasticity of BMI and the probability of being overweight with respect to nutrition-education funding. We find the elasticity of BMI with respect to nutrition-education funding is -0.00006 and the elasticity of overweight with respect to nutrition-education funding is -0.00276. Therefore, if we increase state-level educational funding by 100% this will result in a 0.006% decrease in average BMI at the state-level per year, all else equal. This equates to a reduction in BMI from 26.66 kg/m^2 to 26.51 kg/m^2. Accordingly, under an assumption of linearity, to reduce BMI by approximately 13.64% from 26.66 to 23.00 kg/m^2, a BMI-level within the normal range, nutrition-education funding would have to increase by 22.73 times. This translates to an increasing in annual average spending on nutrition education from $1.5 million to approximately $34 million over the 15 year period spanned by the analysis. These effects are fairly small at approximately $2.27 million per year.

Consider the difference between third-party medical costs associated with obesity or having an above normal BMI in comparison to the costs of a nutrition-education program. Our paper reported that Medicare and Medicaid are spending $24.5 billion annually (see Table 1) on the health consequences of obesity and the USDA has spent a total of nearly $248 million on state-level nutrition-education spending at the state-level with the result of reducing individual BMI and probability of overweight. While it is unknown if these reductions are associated with reductions in Medicaid and Medicare's spending on the health consequences of obesity, our results do suggest that nutrition-education is associated with reductions in BMI and the probability of overweight. Therefore, since this is the first study to make such an association our results are useful and informative to policy makers and the general public.

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Figure 1: BMI growth

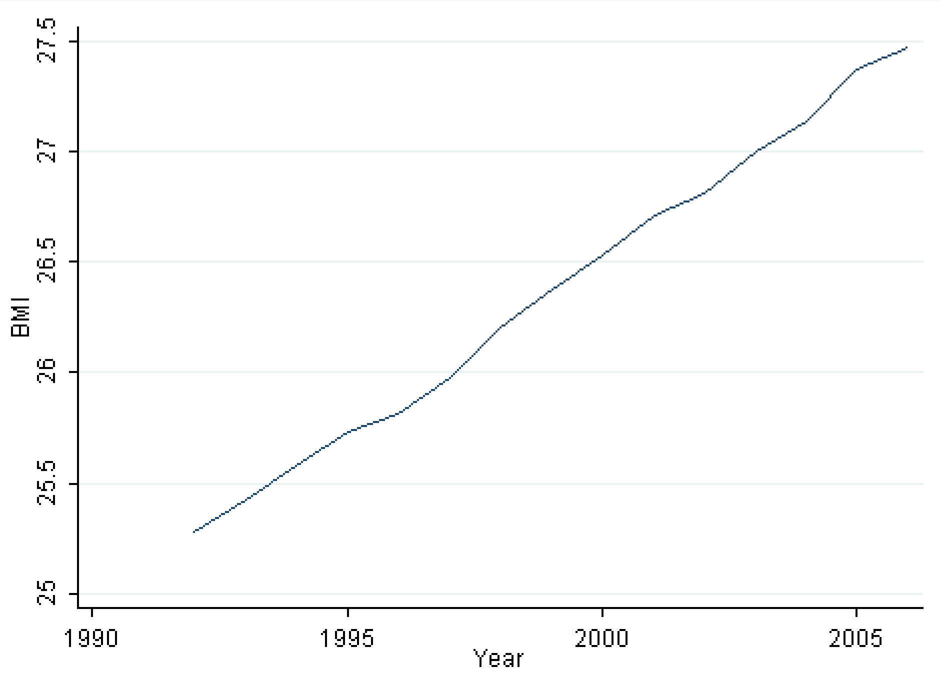

Figure 2: Trend in Overweight and Obese from 1992-2006

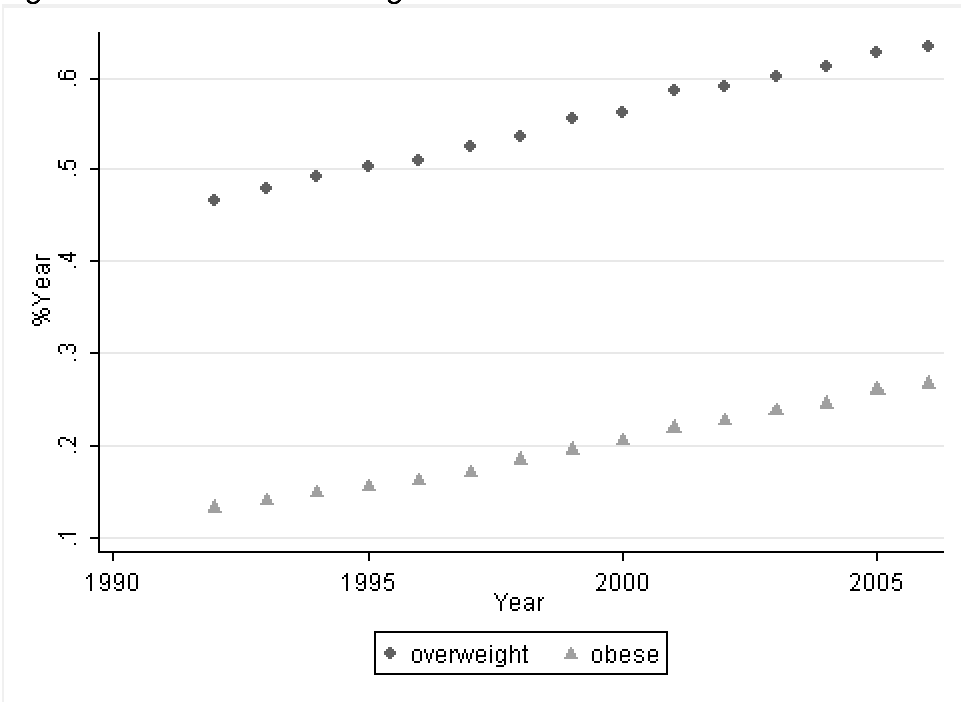

Figure 3: Total Real Nutrition Education Program Funding per Year ($/100 million)

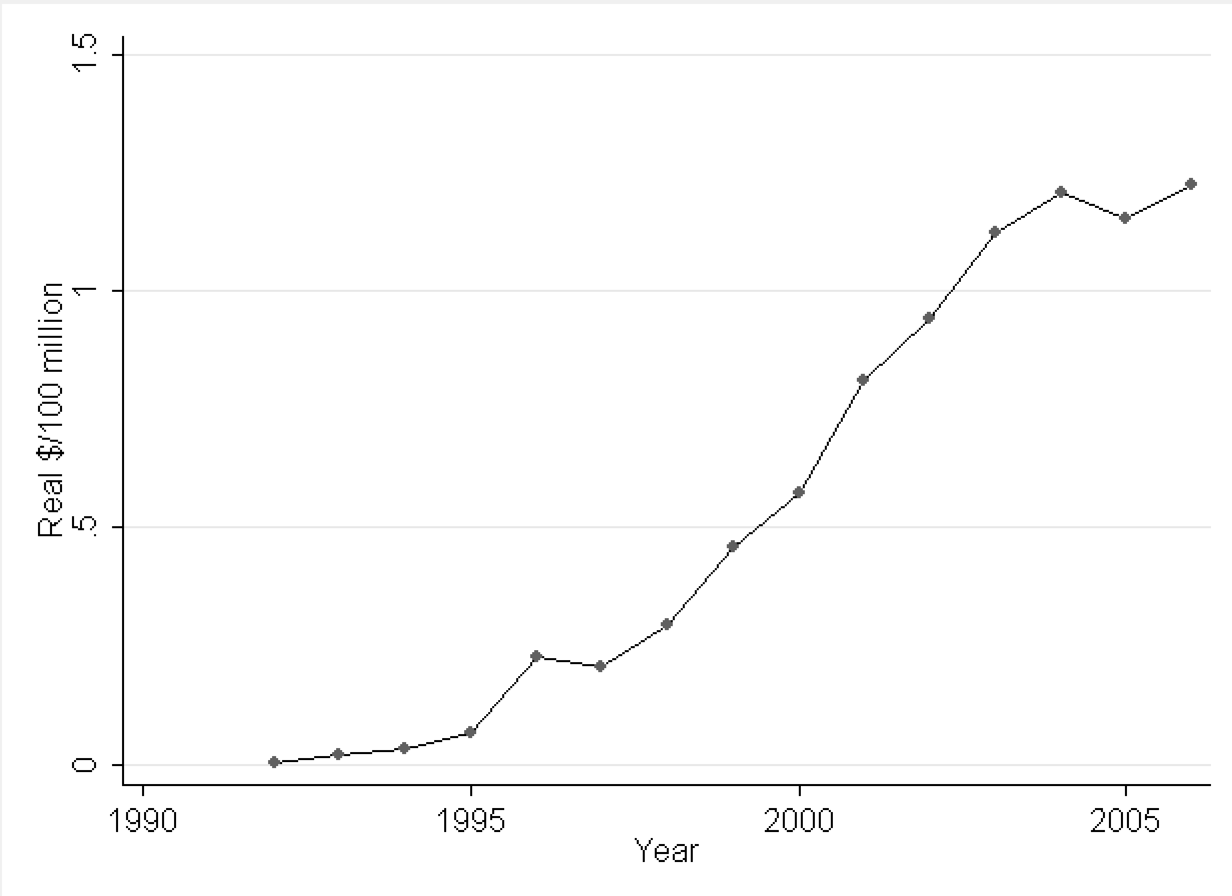

Table 1. Aggregate Medical Spending, in Billions of Dollars, Attributable to Obesity, by Insurance Status and Data Source, 1996–1998

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 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.

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 (reported above)	19.225	10.694

Table 4: Individual Effects with State and Year Fixed Effects

Variable	BMI	Obese	Overweight
Real Nutrition-Education Funding (1,000,000)	-0.0021	-0.0000	-0.0003
	(0.0007)a	(0.0002)	(0.0001)b
Male	1.0491	0.0416	0.4680
	(0.0347)a	(0.0060)a	(0.0081)a
Age	0.3233	0.0673	0.0641
	(0.0044)a	(0.0008)a	(0.0007)a
Age Squared	-0.0031	-0.0007	-0.0006
	(0.0000)a	(0.0000)a	(0.0000)a
White	0.0110	-0.0152	0.0272
	(0.1319)	(0.0278)	(0.0308)
Black	2.0722	0.3519	0.4681
	(0.1423)a	(0.0302)a	(0.0332)a
Hispanic	0.6402	0.0710	0.2236
	(0.1503)a	(0.0296)b	(0.0381)a
Married	0.1289	0.0146	0.1233
	(0.0269)a	(0.0058)b	(0.0049)a
Divorced	-0.3395	-0.0787	-0.0131
	(0.0310)a	(0.0059)a	(0.0061)b
Widow	0.1576	0.0278	0.1144
	(0.0293)a	(0.0060)a	(0.0057)a
High School	-0.2837	-0.0811	-0.0228
	(0.0263)a	(0.0059)a	(0.0057)a
College or More	-0.6781	-0.1688	-0.1213
	(0.0415)a	(0.0095)a	(0.0088)a
Employed	-0.1979	-0.0503	0.0186
	(0.0190)a	(0.0036)a	(0.0038)a
Real Income (10,000)	-0.4802	-0.1147	-0.0750
	(0.0111)a	(0.0025)a	(0.0018)a
N	2,262,952	2,262,952	2,262,952

All regressions include state and year fixed effects. Marginal effects are presented.
Clustered standard errors are in parentheses.
"a" indicates significance at the 1% level, "b" indicates significance at the 5% level and "c" indicates significance at the 10% level.

Table 5: BMI, Obesity and Overweight by Education and Income

Variable	N	BMI	Obese	Overweight
Less than highschool	286,888	27.0805	0.2465	0.5994
Highschool	677,052	27.0425	0.2397	0.6067
Some College	1,299,026	26.3643	0.1960	0.5525
Income ≤ $24,999	747,250	27.0113	0.2463	0.5789
$25,000 ≤ Income ≤ $49,999	759,848	26.6868	0.2129	0.5796
Income ≥ $50,000	755,854	26.3097	0.1876	0.5653

Table 6: Interaction Real Nutrition-Education Funding and Education-Level

Variable	BMI	Obese	Overweight
Real Nutrition-Education Funds (1,000,000)	0.009	0.001	0.003
	(0.003)a	(0.001)c	(0.001)a
High School	-0.212	-0.067	-0.008
	(0.015)a	(0.004)a	(0.003)b
Some College or More	-0.592	-0.152	-0.102
	(0.014)a	(0.003)a	(0.003)a
High School * Real Nutrition-Education Funds	-0.010	-0.001	-0.003
	(0.003)a	(0.001)	(0.001)a
College * Real Nutrition-Education Funds	-0.015	-0.002	-0.004
	(0.003)a	(0.001)a	(0.001)a
N	2,262,952	2,262,952	2,262,952

All regressions include state and year fixed effects in addition to the other variables described by equation 1. Marginal Effects are presented. Clustered standard errors are in parentheses. "a" indicates significance at the 1% level, "b" indicates significance at the 5% level and "c" indicates significance at the 10% level. The results for all other included variables are not different from the results presented in Table 4.

Table 7: Interaction Real Nutrition-Education Funding and Income

Variable	BMI	Obese	Overweight
Real Nutrition-Education Funds(1,000,000)	-0.0000	-0.0006	-0.0001
	(0.0024)	(0.0003)b	(0.0002)
$25,000 ≤ Income ≤ $49,999	-0.3160	-0.0935	-0.0106
	(0.0167)a	(0.0043)a	(0.0032)a
Income ≥ $50,000	-0.8111	-0.2118	-0.0857
	(0.0283)a	(0.0066)a	(0.0047)a
$25,000 ≤ Income ≤ $49,999 * Real Nutrition-Education Funding	-0.0005	0.0017	-0.0001
	(0.0012)	(0.0006)a	(0.0002)
Income ≥ $50,000 * Real Nutrition-Education Funding	-0.0085	-0.0003	-0.0014
	(0.0045)c	(0.0003)	(0.0005)a
N	2,262,952	2,262,952	2,262,952

All regressions include state and year fixed effects in addition to the other variables described by equation 1.
Marginal Effects are presented. Clustered standard errors are in parentheses. "a" indicates significance at the 1% level, "b" indicates significance at the 5% level and "c" indicates significance at the 10% level. The results for all other included variables are not different from the results presented in Table 4.