# THREE EMPIRICAL ANALYSES OF BEHAVIORAL AND NUTRITION POLICY INFLUENCES ON DIETARY CHOICES

BY

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DISSERTATION

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# ABSTRACT

This dissertation research is motivated by the reality that an unhealthy diet has long-term health consequences, and is one among the most important factors associated with some of the most prevalent disorders and conditions, including obesity, cardiovascular diseases, hypertension and diabetes. Although there are several factors, including genetics, physiology and evironment that could cause or increase the risk of some of these conditions or disorders, behavioral factors play a significant role in the demand for food products. In the first essay, I find that external stimuli do increase calorie intake, and that restraint behavior does not fully compensate for the excess calories. Another important result is that individuals consuming higher calories show more impulsive behavior but, surprisingly, also show high restraint. My second essay finds important association of added sugars consumption with saturated fat intake and with cholesterol intake. Thus indicating that consumers making healthier choices in one nutrient are not making healthier choices on other nutrients. The third essay investigates effect of nutrition label informational campaign that was undertaken as part of the Nutrition Labeling and Education Act of 1990. I find that the informational campaign had an impact only on select nutrients. Overall, in this dissertation, I establish that behavioral factors and nutrition information influence dietary choices.

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# CHAPTER 1: INTRODUCTION

Diseases associated with dietary excesses and imbalances rank among the leading causes of illness and death in the United States (Mokdad et al, 2004; Surgeon General's Report on Nutrition and Health, 1988.) In 2004, the press release from the Office of Surgeon General reported that the deaths caused by poor diet and physical inactivity rose 33 percent in one decade. Even though diet related diseases and disorders are, perhaps, most severe in the US, it is becoming more widespread in both the developed and the developing world. The obesogenenic environment, according to CDC, promotes increased food intake, nonhealthful foods, and physical inactivity.

It is, therefore, important to understand factors influencing food consumption. Although there are several factors, including genetics, physiology and evironment that could cause or increase the risk of some of these conditions or disorders, behavioral factors play a significant role in the demand for food products. Identifying the underlying behavioral mechanism can help us better understand why people overeat. My first dissertation essay investigates the role of external (or environmental) and internal (self) impulsivity in food consumption. The second essay analyzes the role of nutrition label informational campaign on dietary outcomes. Each of the essay helps understand factors that influence food consumption. The third essay examines the association between fat related dietary choices and added sugars, particularly at higher levels of added sugars consumption.

In the first essay, I use validated psychometric measures to estimate the effects of impulsivity and restraint on calorie intake and excess calorie intake. Experimental studies have shown that quite often dietary decisions are not dynamically consistent: even individuals who plan to eat healthily often eat unhealthy foods (Read and van Leeuwen, 1998). Economists have proposed a dual-self framework to model such dynamically inconsistent behavior (Thaler and Shefrin, 1981; Gul and Pesendorfer, 2004; Fudenberg and Levine, 2006; Brocas and Carillo, 2008). In this framework, each individual has two selves, the long-run self and the short-run self, who play distinct roles in decision making. The long-run self is hyperopic and therefore takes into account the long-run implications of decisions. In contrast, the short-run self is myopic, does not take long-term impacts into consideration and is therefore more impulsive. The outcome of any situation is based on the interaction of the two selves. There is also neuroscientific evidence of different regions of the brain that are distinctly active in short-term and long-term decisions (McClure et al., 2004).

The dataset contains a behavioral questionnaire that allows estimation of both impulsiveness and restraint. I test whether self-control problems, the interaction of impulsive and restraint selves, increase calorie intake. I find that impulsiveness leads to an increase in calorie intake greater than the calorie reduction caused by exercising restraint. Exercising restraint or control is generally referred as self-control. Furthermore, the marginal effect of impulsive eating is higher and that of restraint is lower at higher levels of calorie intake compared to estimates at lower levels of calorie intake.

The second essay uses media content analysis in a difference-in-difference framework to study consumer response to a mass-media educational campaign undertaken as part of the Nutrition Labeling and Education Act of 1990 (NLEA). Since Nutrition Facts Panel (NFP) is the only source of nutrition information available at the point-of-purchase, prodigious efforts were undertaken to increase public awareness of the new nutrition label among consumers and to teach them to read the nutrition label to make healthier choices. The nutrition-label informational campaign involved propagating information on news media, including TV networks and newspapers, and through various public health and nutrition agencies at the county, state and national levels (van Wagner, 1994; Kurtzweil, 1994).

Most of the existing literature has studied the impacts of the standardization of labels but have largely ignored the campaign effects on dietary outcomes. The standardization of nutrition labels was indeed the more important part of NLEA, but effective communication was key to informing citizens on how to use the information presented in the NFP. In this paper, I use time and spatial variation in the nutrition-label information dissemination. Implications of the limited impact of the informational campaign on communication of nutrition information to the public are also discussed.

The third essay examines consumer choice of food products considering the healthfulness of multiple nutrients. I focus on high levels of added sugars, as they are associated with adverse health and nutritional outcomes. Unhealthy outcomes include, dental caries, dyslipidemia, obesity, bone loss, fractures and diabetes, and adverse nutritional outcomes, include diet with low amounts of micronutrients and vitamins. It is also interesting to look at the relationship between added sugars and fat. In particular because, added sugars and fat in combination show two interesting phenomenons that have significant health implications. One is that they, in combination, are more fattening than when consumed separately; secondly, they increase the hedonic pleasure from food that makes the food more desirable.

I observe an important linkage between saturated fat and added sugars. At higher levels of added sugars intake, individuals who were making better dietary choices based on saturated fats were consuming more added sugars.

Overall, in this dissertation, I establish that behavioral factors and information influence dietary choices.

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# CHAPTER 2: DOES IMPULSIVITY INCREASE CALORIE INTAKE?

## Introduction

According to the Centers for Disease Control and Prevention (CDC), healthy eating and regular physical exercise are the keys to maintaining healthy weight. In the literature, there is a consensus that calorie intake has increased and that calorie expenditure has decreased over the last few decades (Cutler et al., 2003; Philipson and Posner, 2003; Popkin and Gordon-Larsen, 2004; Popkin, 2006). In this study, I attempt to find whether self-control problems, the interaction of impulsive and restraint selves, increase calorie intake. Identifying the underlying behavioral mechanism can help us better understand why people overeat. Experimental studies have shown that quite often dietary decisions are not dynamically consistent: even individuals who plan to eat healthily often eat unhealthy foods (Read and van Leeuwen, 1998). I test whether impulsivity leads to an increase in calorie intake greater than the calorie reduction caused by exercising restraint. Previous studies on impulsivity and calories were mostly undertaken in an experimental setting involving small samples of, typically, less than 100. Here, I use secondary data for a random sample of about 1,500 residents of the United Kingdom (UK). This makes our findings more representative and applicable to a broader population.

Recent theoretical developments in economics to understand self-control problems have drawn evidence particularly from neuroscience and psychology and proposed models of a dual-self that explicitly account for restraint and impulsivity (McClure et al., 2004; Gul and Pesendorfer, 2004; Fudenberg and Levine, 2006; Brocas and Carillo, 2008). Thaler and Shefrin (1981) had proposed a general framework of a dual-self in 1981. In this framework, each individual has two selves, the long-run self and the short-run self, who play distinct roles in decision-making. The long-run self is hyperopic and therefore takes into account the long-run implications of decisions. In contrast, the short-run self is myopic, does not take long-term impacts into consideration and is therefore more impulsive. The outcome of any situation is based on the interaction of the two selves. In the case of dietary choices, dual-self simply refers to two selves in an individual in the time dimension. One self prefers action that increases current utility, and the other self prefers that which will benefit in the future. In this study, the former is measured by impulsivity and the latter by restraint. Such time inconsistencies are very relevant to the case of dietary choices since food not only satisfies an individual's calorie needs and gratifies in the present but also has long-term health effects. I measure calories that could be attributed to the two selves and thereby help understand if excess calories could be attributed to such interactions within an individual. While discussing excess calorie intake due to impulsivity or reduced intake by exercising restraint, it is important to note that a pound of body weight can be gained in a year by consuming only about 10 extra calories a day.

Excess calorie intake has been attributed to economic incentives such as decreases in the price of calorie-dense foods or per unit calorie, increased opportunity costs of meal preparation at home and decreased cost of food away from home (Finkelstein et al., 2005; Rosin, 2008). There are also long-term health benefits of maintaining a healthy diet that provide incentives to exercise restraint so as to consume only optimal (in the long run) amounts of food. However, exercising restraint requires high willpower or self-control, which is especially important because of the ubiquity of food and the economic incentives that lead to excess calorie intake (Thaler and Shefrin, 1981; Bénabou and Tirole, 2004). In fact, self-control problems could be exacerbated in an environment where tasty and convenient foods are cheaper (Cutler, Glaeser and Shapiro, 2003). According to Stutzer (2007), most studies have ignored increase in caloric intake due to problems of self-restraint or of yielding to impulsive tendencies, and neglected the distinct interaction of impulsivity and restraint in a food environment characterized by convenience and ubiquity.

This study attempts to understand dietary choices to identify calorie intake owing to impulsivity and restraint. I construct standard psychological measures using the responses to the Dutch Eating Behavioral Questionnaire (DEBQ) of the National Diet and Nutrition Survey (NDNS) conducted in the United Kingdom (UK). These measures have been tested for their validity and applied to a broad range of population with different weights as well as across gender, ethnicity and countries (van Strien, 2002; Bardone-Cone and Boyd, 2007).

To test for robustness of these estimates among individuals with different levels of calorie intake, I use quantile regression, which is also robust to observed and unobserved heterogeneity

(Chernozukhov and Hansen, 2006). Below, I discuss three reasons on why I might expect heterogeneity across the conditional distribution of the calorie intake. They are heterogeneity in understanding and modeling the food environment facing individuals; modeling food intake behavior; and the impulsive behavior across the conditional distribution.

The DEBQ obtained responses of individuals in different food situations. But individuals could be facing different food environments or situations (Jeffrey and Utter, 2003; Paquet et al, 2010) which are not captured here and therefore remain part of unobservables. For instance, one question asks how likely is a person to buy something when walking past a bakery, snackbar or cafe. In the dataset, there is no information on the number of bakeries, snackbars or cafes a person might be passsing by. Therefore, even though the respondent only "sometimes" buys something delicious, the person passing by more of such food stores could be buying more than a person passing by fewer food stores. Similarly those offered food or drink many times, may be accepting more food or drink compared to those offered fewer times - even though both might only "seldom" accept such foods. None of the options in the DEBQ distinguish such heterogenous situations facing individuals. Quantile regression provides more reliable estimates in the presence of such unobserved heterogeneity compared to OLS (Koenker, 2005).

The NDNS respondents were required to record seven consecutive days diet. In this study, each individual observation is the average of the seven days for each individual. Although means give a better picture of daily calorie intake, there is considerable variation in the seven-day intake for each individual across the distribution as clearly shown in Figure A in the Appendix. There are two important observations: 1) the standard deviation increases with total calorie intake as shown by the fitted (dotted) line; 2) the dispersion of standard deviation itself increased with total calorie. NDNS does not have information to account for these individual level unobserved factors that is causing such differences in variability in the calorie consumption. The above two observations suggest that there is heterogeneity among individuals by the level of total calorie intake. Quantile regression provides reliable estimates in the presence of such systematic (increase by levels of calorie intake) unobserved heterogeneity (Chernozhukov and Hansen, 2006). This distinction across levels of calorie intake is accounted for by allowing the intercept term to vary across the conditional distribution – in a quantile regression framework.

I also conjecture that the marginal effect of impulsive eating is higher and that of restraint is lower at higher levels of calorie intake compared to estimates at lower levels of calorie intake. The idea is that individuals at the higher end of the conditional calorie distribution are more susceptible and are more likely giving in to impulsive influences. Quantile regression, by allowing the coefficients of each variable to vary across the conditional distribution, accounts for such heterogenous effects, and also allows testing if marginal effects vary (Koenker and Hallock, 2001).

Apart from accounting for heterogeneity, quantile regression is also useful from a health policy perspective. Even though estimating calorie intake differences due to impulsivity and restraint is important, it is more important, from a public health perspective, to understand the role of self-control problems at higher levels of calorie intake. To assist policymakers in designing effective health intervention, it would be more useful to provide results especially for those individuals who need more attention. If individuals consuming high amounts of foods eat impulsively in response to emotional factors, then improving food environment to reduce calorie intake would not be effective, at least for those in most need. Emotional eaters need better strategies to cope with their emotions while external eaters need better strategies to reduce exposure to food.
The ordinary least squares (OLS) averages the marginal effects in the entire distribution which does not allow us to know if impulsivity and restraint are leading to more intake at higher levels or not. The fact that an additional pound of body weight is added by adding just ten additional daily calories over a year makes it all the more important to understand self-control problems at different levels of calorie intake.

The rest of the article is organized as follows. The following section discusses the neuroscientific evidence for the dual-self model. Section III briefly describes the theory, and the hypotheses are outlined in section IV. The survey data and psychological measures are described in section IV. Results are discussed in section V and conclusions drawn in section VI. Apart from total calories, I also present results on calories from fats and sugars since these are associated with obesity. Foods with a higher proportion of fat and sugar generally have more calories, and are more energy (calorie) dense, more ubiquitous and cheaper than healthy foods (Drewnowski, 2003; Drewnowski and Darmon, 2005).

**Neuroscience of Dual-Self**

In this section, I provide neuroscientific evidence of dual-self in an individual. Using functional magnetic resonance imaging (MRI), McClure et al. (2004) demonstrated that two separate systems in the brain are involved in intertemporal decisions[1]. Specifically, decisions involving immediately available rewards activated the mesolimbic dopamine system, while intertemporal choices engaged regions of the lateral prefrontal cortex and posterior parietal cortex (cortex system). The latter was true irrespective of the delay in realizing choices. The limbic system, on the contrary, does not respond to costs and benefits delayed more than a few minutes. Moreover, each individual's choice was directly associated with the relative engagement of the two systems.

The following studies also suggest that impulsive choices can be restrained, and that they involve different regions of the brain. Affective reactions to taste are highly sensitive to neural manipulations, which according to Berridge and Robinson (2003), implied that the "onset, quality, quantity and duration of an eliciting gustatory stimulus" can all be controlled. Kalenscher et al. (2006) have clearly shown that impulsivity and self-control are two antagonistic choice dispositions. In particular, they found that mammalian forebrain structures play a key role in determining the time and length of response inhibition. According to Knoch et al. (2006), the right dorsolateral prefrontal cortex plays a key role in overriding self-interested impulses.

If our innate impulse is to eat more and the trained or tempered behavior is to restrain, then these constructs are measuring the two processes in an individual that are antagonistic. Behavioral economists and psychologists have termed these internal inconsistencies in preferences as intrapersonal conflict. Economists have recognized and modeled the dual-self, and the following section presents some of the studies that provide a basis for using the dual-self framework in this study.

[1] The experiment involved asking the subjects to chooose from a series of choices between monetary reward options that varied by delay to delivery.

**Theory and Hypothesis**

The key argument in favor of the dual-self model is it, according to Fudenberg and Levine (2006), "gives a unified explanation for several empirical regularities," including time inconsistent choices. Previous studies have used the hyperbolic discounting model to explain dynamic inconsistency in choices. In such models, self-control and impulsivity is implicit in the discount rates. Fudenberg and Levine argue that self-control is an exhaustible resource that is part of the entire mental capacity and therefore needs to be explicitly modeled. The data used in this study have variables that allow us to explicitly measure the restraint (or self-control) and impulsiveness of an individual in regards to food. In this study, impulsive self refers to the myopic agent (Brocas and Carillo, 2008, BC model), doer (in the TS model) or short-run self, while the long-run self refers to the principal (in the BC model) or planner (in the TS model).

The questionnaire available in the data is exclusively designed to measure a person's impulsive response and restraint behavior with regards to food intake. In the experimental stage, the questions included in the DEBQ explained 88 % of the variance (van Strien et al., 1986) and therefore very closely measure the intended human response to food-related cues. Thus I rely on psychological measures to test whether intrapersonal conflict leads to increased caloric intake.

I utilize the psychological constructs available from the DEBQ to measure how people tend to respond to food characteristics, the food environment, and their internal states such as, depression, fear, or loneliness. These measures provide evidence that suggests a causal effect but does not establish it. An ideal variable for understanding true calorie intake owing to impulsivity and self-control would be MRI scans made while individuals are making dietary choices, showing the intensity of the two subsystems described in the neuroscientific evidence section. With information on the relative engagement of the two systems, one could more accurately predict calorie intake. I do not have such data and therefore must construct psychological measures from questions in the survey that ask individuals to indicate how likely they are to eat or exercise restraint in certain situations. This more accurately reflects how an individual perceives him- or herself given past experience. These measures have been used in previous studies particularly in the psychology literature and are described in more detail in the data section. The DEBQ was particularly incorporated into the survey because, according to the report, it was one of the few that has been validated. The psychological measures are described below.

**Data**

The data including the psychometric variables are described in this section.

*National Diet and Nutrition Survey (NDNS), 2000-01*

The National Diet and Nutrition Survey was conducted by the British Food Standard Agency (FSA) and the Department of Health (DH) to collect information on the dietary habits and nutritional status of the population in Great Britain over seven consecutive days. This study uses the latest survey of adults aged 19 to 64 years, from the year 2000. The Social Survey Division of the Office for National Statistics (ONS) and the Medical Research Council Human Nutrition Research Cambridge (HNR) were commissioned to carry out this survey.

A nationally representative sample was selected from among those living in private households, with only one respondent per household. The fieldwork for data collection was divided into four waves[2] that spanned the 12-month period to cover any seasonality in dietary choices or behavior. The sampling frame was stratified by the 1991 Census variables and included all the postal sectors within mainland Great Britain. Sample selection was based on multi-stage random probability design. A total of 152 postal sectors were selected as first stage units with probability proportional to the number of postal delivery points. Of the 152 postal sectors, each of the four fieldwork waves covered 38 sectors, and within each postal sector, 40 addresses were randomly selected.

An achieved sample of 2,000 respondents was needed for analysis and comparison with the previous survey (1986/87 Adult Survey). Important considerations in selecting the sample size

[2] Wave 1: July to September 2000; Wave 2: October to December 2000; Wave 3: January to March 2001; Wave 4: April to June 2001

were the costs of blood analysis and anthropometric measures, and the cost to the individual in maintaining the seven-day dietary record. Eligibility of the participating individual was simply the age criteria and not being pregnant or breastfeeding. A large number (35%) of the randomly selected addresses were ineligible. Of the eligible sample, 61% (n=2251) completed the dietary interview, but only 77% of these completed the seven-day dietary record. Thus the response rate for the seven-day dietary record was 47% (n=1724). The proportion of the sample completing the diary record was lowest in the youngest age group, 19 to 24 years for both men (71%) and women (72%), and highest (78% for both sexes) in the oldest age group, 50 to 64 years. The actual sample size is 1,724 but only 1,466 observations are used in the regression models due to non-response for some variables.

A weighed food inventory method was used for recording all food and drink consumed both at home and away for seven consecutive days. In this method, the individuals were required to weigh and record their food intake using PETRA scales provided by the survey team. The advantages of this method are that the information collected is more accurate, there is better measurement of day-to-day variation and there is much less reliance on memory (Anderson, 1995). The disadvantages are that recording each meal might change eating habits, particularly for those watching their diet; it requires subjects to be literate; it requires a high degree of cooperation and it is time-consuming for the subject (Anderson, 1995). However, previous nutrition studies have found that ensuring sufficiently accurate results of energy and macronutrient (carbohydrate, protein and fat) intake in adults would require between four and seven days of dietary record with the exception of studying protein intake in females, which required eight days (Black et al., 1983; Nelson et al., 1989; Bingham et al., 1995).

A feasibility study was carried out before the main survey testing the validity of the dietary recording methodology by comparing energy expenditure against energy intake. This was undertaken to understand whether recording food intake for seven consecutive days and other aspects of the study were feasible. Further details of the feasibility study are presented in Appendix C of the NDNS report. Extensive training was provided for the interviewers, which among other parts included a five-day residential briefing and required successful completion of the researcher's own three-day weighed intake record.

An important component of the survey cross-checks for any underreporting with the self-completion of the Psychological Restraint Questionnaire (Eating Habit Questionnaire) and for circumstances or illness that would have affected normal eating behavior. Respondents who completed seven days of dietary records were awarded £10.

Due to the length and detail of the survey, it suffered from a low response rate. Skinner and Holmes (2002) studied the potential impacts of the non-response on the usability of this survey data. They found evidence for differential non-response[3] effects, but the bias in the estimates based on nutritional variables rarely exceeded one percent. The main reason they cite is that the variables associated with differential non-response are not strongly associated with the nutritional variables. Although non-contact proved to be more differential in the health variables, it was only four percent in this survey; therefore its bias should be relatively minor if not absent. The non-cooperation rate was lower and was fortunately only slightly related to health and nutritional variables. The authors concluded that weighting should be used for obtaining population estimates but that it was not essential to adjust for non-response.

*Psychological Construct of Impulsivity and Self-control*

The respondents were asked to fill out the DEBQ as part of the survey. All of the questions in the DEBQ[4] can be categorized as constructing three scales that measure the respondents' emotional eating, external eating and restrained eating predispositions. The psychometric construct has internal consistency[5], convergent validity[6] and discriminant validity[7] (van Strien et al., 1986; van Strien, 2002). Each question had the options never to more often on a five-point Likert scale

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[3] This refers to differences in response rates across specifdic characteristics, such as the low response of a particular ethnic group.

[4] All questions are listed in the Appendix.

[5] Internal consistency is a measure based on the correlations among different items on the same scale. van Strien's study found that it was consistent over a range of individuals by BMI and gender. Cronbach's alpha was 0.80-0.95.

[6] Convergent validity shows that the scale is related to what it is intended to measure.

[7] This indicates that the measures are mutually exclusive.

and hence captured the degree of the measure. Thirteen questions were used to construct emotional impulsivity; ten questions each for the external impulsivity and restraint measures.

To determine the number of questions to measure each of the behavioral responses, van Strien et al. (1986) used factorial analysis. Therefore the number of questions does not bear any significance except to capture more variation in the measured behavior. Since the objective of each question was to measure the breadth of the respective innate response, I added up all the questions within the category that they were intended to measure. To compare the caloric intake among the three measures, I divided each by the number of questions. This essentially states how impulsive a person is on a scale from one through five.

Emotional eating, based on psychosomatic theory, measures the degree of the desire or natural tendency to eat in different emotional states such as fear, anxiety, hunger or depression, which are internal cues. External eating, based on externality theory, measures the degree of an individual's response to food-related stimuli, regardless of the internal state of satiety or fear. For example, external eating studies whether an individual eats more if the food tastes good.

Other than response to emotional states or external cues, individuals could deliberately eat less to lose weight or maintain a healthy weight. The restraint eating measure assesses deliberate ways of regulating eating because of concerns related to body weight. Some ways individuals control food intake are by eating fewer or smaller meals or eating fewer snacks. The first two measures, emotional and external eating, indicate impulsiveness, while the latter indicates self-control. Higher emotional or external eating scores imply higher impulsiveness and vice versa. Similarly, higher restraint eating scores imply higher self-control and vice versa.

In discussing the estimates of psychological measures, I assume consistency in impulsivity and restraint in all meal occasions. For instance, if a respondent is more likely to eat when in a depressed mood, he or she is assumed to be more likely to eat comfort foods whenever in a depressed mood during the seven-day period of the data collection. This can be restated in two different ways: 1) the model specified here assumes a person to be consistent in the degree of impulsivity and self-control; or 2) the coefficient indicates average impulsivity and self-control throughout the seven-day period.

*Descriptive Statistics*

Sample averages are calculated for all continuous variables, and proportion is shown for each categorical variable in Table 1. The mean total calorie intake was a little less than 2,000 calories. Although this figure seems lower for a developed nation, it is consistent with most surveys around that time period[8]. Impact of underreporting on the estimates is discussed in the results section. About 20 percent of the respondents were on a diet. Even though all the psychological measures had very similar means, the scores were higher for impulsive measures, the emotional and externality eating scales, than for the restraint measure. The average Briton spent most of the time, about 14 hours, on light activities, followed by sleep, about eight hours, and the least amount of time on strenuous physical activities.

In 2000-01, the average Briton was 42 years old, earned £19,000 and came from a household of 2.6 members. About 46 percent had some level of GCE or GCSE grades, and fewer than 20 percent had a college degree. Surprisingly, about 20 percent of the respondents indicated they had none of the qualifications listed in the survey questionnaire. Females constituted a slight majority of the respondents. Respondents fairly represented the different regions in UK, with the most from the Southeast and the fewest from Merseyside.

## Analytical Framework

In the survey, the households were required to keep a dietary record for seven consecutive days, which allows us to obtain reliable average daily estimates of activities and intake observations. The econometric model to obtain the estimates of the psychological variables is specified as

$$(1) \qquad y_i = \beta_o + \sum_{j=1}^{3} \beta_{1j} M_j + \beta_2 X_i + u_i, \quad i = 1,...,n;\ j = 1,2, and\ 3,,$$

where yi is the seven-day average calorie intake of the ith individual, Mj is the jth psychological measure, Xi is the vector of individual characteristics and ui is the idiosyncratic error term. The

[8] Natinoal Food Survey reports total calories to be 2,056 (year 1999), 2,152 (2000), and 2,089 (2001). http://www.heartstats.org/datapage.asp?id=931 (a research group in the University of Oxford). Accessed 28 May 2010.

psychological measures, M vector, include emotional impulsive eating, restrained eating and external impulsive eating. I specify the above model in two different ways. In the first specification, equation 1 is estimated as is. The second specification is estimated in two different steps: 1) the average daily calorie number is regressed against variables that measure the intensity and duration of physical activity; 2) the residual from the equation in step-1 is regressed against all the M and X variables excluding the physical activity variables in equation 1. Essentially, using the regression of levels of physical activity (PA) on calorie intake, I take out the calories due to PA. The remaining calories, residuals, are then regressed on the remainder of the variables. This is a partition regression method. Consistent estimates in the above two specifications are evidence that the two sets of variables, physical activity and the psychological measures, are orthogonal. In this section, I provide neuroscientific evidence of dual-self in an individual. Using functional

**Results**

In this section, I present the main results that answer the research question posed above, and address potential misreporting in the dataset. All standard error estimates heteroskedastic-consistent standard errors.

*Do Self-control Problems Increase Calorie Intake?*

While discussing the magnitudes of the coefficients, one should bear in mind that the scale of each measure ranges from one through five. Thus each coefficient represents a response to a unit change in this range and the scales developed here. Table 2 shows the results of the first specification. Those respondents who exercised some degree of restraint (seldom to often) consumed about 64 fewer calories. An individual who was more impulsive (seldom to often) to external factors and emotional states consumed about 120 and 40 more calories respectively.

In the case of fats and sugars, the coefficients were significant but of a smaller magnitude. Similar to the total calories, the absolute magnitude for the external measure was highest, and the magnitude for the emotional measure was either lowest or insignificant in the fat and sugar models. Emotional impulsiveness increased fat intake (19 calories) but not sugars. Similarly, individuals' response to external stimuli increased fat intake (58 calories) more than it did sugars (25 calories). Individuals exercising restraint reduced more calories from fat (45 calories) than from sugar (13 calories). Thus individuals are relatively more impulsive toward fats than sugars, and they also exercise more restraint on fats than on sugars.

Since the three measures have the same scale, one can simply compare the coefficients. Impulsivity reflects the short-run self while the restraint measure reflects the long-run self; therefore I can simply add up the coefficients to test if the sum total of the response is positive intake. Here the total calories increased by about 100 (=117.3 + 41.88 – 63.14), while calories from fats and sugars increased by about 30 and 20 respectively. Thus intrapersonal conflict, as defined in this study, does increase net calorie intake. The partitioned regression also showed similar estimates.

To test whether those on a diet show a specific pattern of response, I interacted the psychological measures with the dieting variable, which indicates if the individual is on a diet to lose weight. Allowing the dieting variable to vary with the psychological measures did not change the estimates significantly for any of the measures, except for emotional impulsivity in the case of total calories. Interestingly, when these interaction terms are introduced in the model, the main effect of the dieting variable becomes insignificant in all three cases (Table 2). This could imply that an individual's decision to diet by itself does not affect calorie intake but only in interaction with external or emotional factors or deliberate attempts to limit food intake.

Since the calorie intake difference between male and female was large, I ran separate regressions by gender. When the same models were run for each gender types, the external environment and restraint psychological variables had similar magnitudes (restraint = 114 and 130; external = 58 and 61), but were not statistically different. However, the emotional variable, which was insignificant in the general model is significant in the case of women (55, p-value=0.014) but insignificant for men (2, p-value=0.972).

*Assessing the Robustness of the Estimates*

To assess the robustness of the estimates, I explore cross correlation effects among the psychometric measures, that is, whether one variable is picking up the effects of some other variable. Table 3 compares the correctly specified model with alternative specifications from different subsets of potentially endogenous variables. The results suggest that the estimates of the specified model do not vary in sign but do vary somewhat in magnitude, except for the emotional eating measure. The external eating measure estimate varied between 101 and 139, the restrained measure between insignificant and -86, the emotional measure between insignificant and 85 and the dieting variable coefficient varied between -134 and -206. These results indicate good robustness of the external impulsivity variable but less so for the emotional impulsivity and restraint measures. The inconsistency of the emotional impulsivity coefficient could be partly because of it is significant only in select points in the distribution. Even if one argues that the restraining effect is not very consistent, the sum effect of impulsivity and self-control only shows higher calorie intake. However, one should keep in mind that these processes co-occur in an individual and are active in any situation leading up to a dietary choice. Therefore all three basic responses need to be accounted for in any particular model measuring calorie intake.

I also ran a regression of the psychological measures and other variables, excluding physical activity, on the residuals of the regression of physical activity on total calories (Table 4). These estimates are not statistically different from those in the original equation. Further, the results from the interaction of psychological measures and dieting variable also show robustness of the estimates of the measures.

*Addressing Misreporting*

I address underreporting more extensively than overreporting as the former is more commonly observed (Johansson et al., 1998). Underreporting is associated with certain demographic characteristics such as gender (women) and level of education, age, and health behaviors such as smoking habit and physical activity (Briefel et al., 1997). All these characteristics except smoking were included in the model (reported in Table 2) thus accounting for any underreporting specific to characteristics. In the NDNS, about two-third of the respondents did not answer the question on smoking so it could not be used as a control variable. Running a separate regression for those who smoked and controlling for the number of cigarettes smoked per day did yield estimates that were closer to those reported in Table 2 except for the emotional impulsivity measure which was almost double in the smokers-only regression[9].

A review on underreporting in dietary surveys by Macdiarmid and Blundell (1998) found that underreporting based on demographic characteristics is less consistent across studies but is more common among overweight and obese individuals. Since different levels of underreporting by Body Mass Index (BMI) weight categories were observed, I ran separate regressions for normal weight, overweight and obese individuals[10] (Table 5). Normal weight individuals impulsively (external measure only) consumed fewer total-calories than the entire sample estimate in Table 2 but the restraint measure was not significant. The overweight and obese individuals impulsively consumed about 40 and 5 more total-calories than the entire sample estimate. For fats, the normal weight and overweight consumed 6 and 30 more calories but the obese individuals showed no significant increase in calories. A similar pattern was observed in restraint behavior across individuals by weight categories.

In contrast to total calories and fats, psychological variable estimates in the sugars intake model were insignificant except for external impulsivity for overweight individuals and restraint measure for obese individuals. This is not very surprising since snacks are the most underreported items in dietary surveys (Macdiarmid and Blundell, 1995; Pryer et al., 1997; Lafay et al., 2000), and sugars mostly come from snacks[11]. If there is a mix of underreporters and true

[9] Calorie estimates for external impulsivity was 108 (p-value 0.026), restraint -65 (0.046), and for emotional impulsivity 77 (0.079). These are available from the authors.

[10] Classification based on BMI was as follows: Underweight (<18.5); Normal (18.5 – 24.9); Overweight (25.0 – 29.9); Obese (≥30.0).

[11] The Third Report Session in 2003-04 on Obesity by the Health Committee, House of Commons, noted that the individuals in the dietary surveys reported consuming 82 grams of confectionary a week, whereas the industry supply data shows 250 grams. Report (Accessed on 25th May, 2010): http://www.publications.parliament.uk/pa/cm200304/cmselect/cmhealth/23/23.pdf.

reporters then the variance could be higher which could render the variable insignificant in the model.

The above discussion on underreporting discusses ways to address non-random errors, that is, associated with identifiable characteristics or attributes. Heitmann and Frederiksen (2007) found that underreporting could even be random. Thus, assuming that most of the low energy reporters are actually reporting very low calories, I run separate regressions by excluding those reporting less than 500, 1000 and 1200 calories (Table 6).

Overall, the magnitude of the coefficients is very similar to the main results in table 2 with few exceptions that were statistically different. The external impulsivity coefficient was significantly different only for the overweight category in the case of fats; and for the normal weight and obese categories in the case of sugars. The restraint coefficient was significantly different for the normal wight and overweight categories in total calories; overweight group in fats; and all of the weight categories and whenever overreporters were excluded in sugars. The emotional impulsivity coefficient was insignificant in all regressions implying no significant differences across weight categories, and when underreporters were excluded, and also when underreporters and overreporters were excluded in total calories, fats and sugars.

Although overreporting is present in dietary surveys, it is observed much less frequent than underreporting. If overreporting is non-random and associated with specific demographic characteristics, they are accounted for in the model results presented above, particularly in Table 2. Lara, Scott and Lean (2004) reported observing different proportion of overreporting by body weight categories, as indicated by BMI. Table 5 presents those results. I also address random overreporting by re-estimating the model after excluding those reporting higher than 4,000 and 3,500 calories in Table 7. Only about 70 respondents are excluded using such calories criteria.

Addressing underreporting in several ways as discussed above would only account for underreporting on average. If it is intake that is not reported then the true psychological impulsive coefficient should be much higher and the true restraint coefficient much lower. Lower reporting of snacks in particular was associated with dietary restraint measures (Lafay et al.,

2000) suggesting a much lower (true) estimate of the restraint variable. Thus the actual absolute difference between impulsive and restrained intake would be much higher than is estimated in this study. In other words, the coefficients estimated here might be lower than the true value.

*Do Self-Control Problems Lead to More Intakes at Higher Calorie Levels?*

If the effect of self-control and impulsivity varies over the dietary intake distribution, it may have important implications for food and nutrition policy. To examine this possibility I utilize quantile regression. The first observation in the quantile regression model is that the emotional impulsivity that accounted for a significant portion of calories in all the three categories is not significant above the median quantile (Tables 8, 9 and 10). Further, the calorie intake owing to external impulsivity is increasing, while that owing to restraint is decreasing (increasing in absolute terms), at the upper quantiles of the distribution of total calories and sugars. But the calorie difference between impulsiveness and restraint is decreasing at the upper quantiles. In other words, individuals who consume more calories make a greater attempt to reduce calories but do end up yielding more to impulsive influences and thereby nullifying any effect of restraint. This difference between impulsive and restrained eating in the upper tail (0.75q and 0.90q) of the distribution is more than 55 calories of total calories (Table 8) and more than 20 calories from sugars (Table 9). In the case of fats, the difference at 0.75q was 35 calories but less than two calories at 0.90q (Table 10). Thus self-control problems have led to more calorie intake at higher levels of total calories and sugars but fewer with fats.

*Other Variables*

Although not the variables of interest in this study, a discussion of the other variables shows to some extent the validity of the model. The coefficient of the income and age variable are positive, implying an increase in calories with increase in income and age. This increase, however, decreases, as shown by the negative coefficient of the respective squared term. The mean calories range from 350 to 4790 with a mean of 1930, so it is no surprise to see that the coefficient of income is positive. Individuals who were on any diet to lose weight consumed 127 to 142 fewer calories on average compared to those not on diet.

In all the models, the coefficients of the activities variables increase with the level of difficulty. For instance, Table 2 (on total calories) shows an estimate of 0.64, 0.55 and 0.4 for hard, moderate and light activities. Taller individuals have a higher calorie requirement; this is clearly shown by the positive coefficient of the height variable. Survey research has also shown that women consume fewer calories than men. This could be partly physiological as women have lower lean body mass (Cunningham, 1982).

*Self-control Problems and BMI*

These psychological variables ask about food consumption and therefore primarily affect calorie intake, a current outcome. Therefore, these variables might not fully measure changes in BMI, a future outcome. It would be interesting, however, to look at the association between self-control problems and BMI. Each unit (out of five) increase in the restraint scale is associated with 0.72 unit increase in BMI, and a unit increase in emotional scale is associated with 1.3 units increase in BMI. Not such association was observed between external scale and BMI.In this section, I provide neuroscientific evidence of dual-self in an individual. Using functional

## Conclusion

This study was undertaken to study the effects of impulsive influences on calories consumption from all sources, fats and sugars. A simplified dual-self framework suggests that there are two selves in an individual that are antagonistic in their influence on making a dietary choice. The long-run self, indicated by restraint, argues for healthier food that will provide benefits in the future while the short-run self, indicated by impulsivity, argues for immediate gratification.

Using the DEBQ from the NDNS dataset, I constructed standard psychological measures to account for impulsive and restraint eating behavior. I found that the UK residents in the study consumed a considerable number of calories impulsively and also restrained intake considerably. However, impulsive caloric intake outweighs calorie reduction by restraint behavior; therefore the result of the interaction of the two selves is an increase in calorie intake by about 100 total calories and 30 and 20 calories from fats and sugars respectively.

Individuals exercise more restraint on fat intake than on sugars but also consume more fats impulsively in response to external stimuli. I find no evidence of an increase in calories from fats or sugars in response to emotional tendencies except at lower levels of calorie intake for the entire sample. However, when the same model was run separately for each gender types, emotional psychological variable did show significant calorie intake for women. Thus women restrained about the same calories compared to men but consumed relatively more calories impulsively.

Furthermore, individuals with higher calorie intake show more impulsive tendencies and therefore need more attention. Individuals consuming higher calories show more impulsive behavior but, surprisingly, also show high restraint. This is contrary to general belief that those consuming higher calories are simply impulsive. Therefore, policies to help people by reducing exposure to food all the time might actually help. From the quantile regression, it is also clear that emotional impulsivity, although present as shown in the mean regresison, is not a concern as it is not significant at upper levels of the conditional distribution.
The external stimuli include marketing strategies of food companies to make their products look, smell and taste good. The companies have also made food products available in most accessible places. Other than food characteristics, external stimuli also include environmental factors such as passing by a bakery. Thus the results are strongly suggestive that the ubiquity and characteristics of food are contributing to a considerable increase in caloric intake. Recent studies have also suggested that higher densities of fast food outlets and the resulting easier access to fast food have a significant impact on BMI (Chen et al., 2009; Dunn, 2010). Richards and Padilla (2009) have also found that promotion of foods increases its demand. Results from this study are supportive of such findings, assuming that an increase in calories leads to an increase in BMI.

The effects of several other variables are in general consistent with existing literature and conditions in the UK. Age and income had a positive effect, but the respective quadratic components had a negative effect.

Underreporting has been addressed in several ways: a) controlling for individual characteristics that have been found to be more related to underreporting such as, gender and education; b) running separate regressions by weight categories; c) running separate regressions for smokers; and d) estimating coefficients after excluding low calorie reporters. The results show consistency of the estimates and suggest that the true estimates could be higher than is found in this study.

Even though the estimates show consistency and robustness, the econometric misspecification of psychometric measures is not fully addressed. The results must also be viewed with discretion especially when applying these results to the entire population because the response rate was only about 50 percent.

In summary, this study clearly indicates that external stimuli do increase calorie intake, and that restraint behavior does not fully compensate for the excess calories. Future dietary surveys with questionnaires seeking information on impulsive and restraint eating behavior would help better understand food consumption behavior.

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**Table 1**: Descriptive statistics and description of the variables.

| **Variable** | **Mean** | **Std. Dev.*** |
|---|---|---|
| Daily calories | 1939 | 794 |
| *Psychological Measures* | | |
| Emotional Eating (13 questions) | 23.1 | 10.4 |
| Externality Eating (10 questions) | 24.7 | 8.1 |
| Restrained Eating (10 questions) | 22.8 | 10.6 |
| Slim (Yes=1 and No=0) | 19 | - |
| *Activity in minutes** (Light activity omitted)* | | |
| Hard activity (e.g. jogging, rowing) | 17 | 80 |
| Moderate activity (e.g. gardening, aerobics) | 76 | 158 |
| Light activity (e.g. clerical work, shopping) | 853 | 183 |
| Sleep | 492 | 98 |
| *Day, place and source of eating* | | |
| Weekend (Friday, sat or sun = 1, else 0) | 29 | - |
| Proportion of mealtimes away from home | 30 | - |
| Proportion of meals made or brought from home | 24 | - |
| *Demographic* | | |
| Age (years) | 42 | 12.2 |
| Income category | 9 | 3.2 |
| Household size (children + adults) | 2.6 | 1.3 |
| Gender (Female) | 55 | - |
| *Education (No qualification omitted. Education levels decrease in order)* | | |
| Degree or equivalent | 17 | - |
| Higher education below degree level | 3 | - |
| GCE 'A' level or equivalent | 6 | - |
| GCSE Grades A-C or equivalent | 30 | - |
| GCSE Grades D-G or equivalent | 10 | - |
| Other qualifications | 14 | - |
| No qualifications | 19 | - |

*Table 1 contd…*

| **Variable** | **Mean** | **Std. Dev.*** |
|---|---|---|
| *Region (North East omitted)* | | - |
| North East | 5 | - |
| North West | 9 | - |
| Merseyside | 3 | - |
| Yorks & Humberside | 9 | - |
| East Midlands | 6 | - |
| West Midlands | 9 | - |
| Eastern | 10 | - |
| London | 10 | - |
| South East | 17 | - |
| South West | 10 | - |
| Wales | 4 | - |
| Scotland | 7 | - |

Note: *not reported for binary variables. **Coefficient of variation for hard, moderate and light activities was 4.7, 2.1 and 0.2. Monthly values are not shown here.

**Table 2:** Robust estimates of calorie intake model.

| Variable | Variable names | All sources | | Fats | | Sugars | |
|---|---|---|---|---|---|---|---|
| | | Slim Inter' | No inter | Slim Inter' | No inter | Slim Inter' | No inter |
| | | (1) | (2) | (3) | (4) | (5) | (6) |
| On slim diet | Slim | -139.3* | -9.879 | -57.67* | -43.01 | -54.68* | 7.872 |
| | | (32.75) | (145.4) | (14.69) | (67.31) | (11.15) | (48.27) |
| Psychological | External | 117.3* | 125.7* | 57.60* | 59.04* | 25.24* | 30.24* |
| | | (23.14) | (25.39) | (10.54) | (11.54) | (8.058) | (8.974) |
| | Restraint | -63.14* | -64.37* | -45.68* | -48.08* | -13.12† | -15.39† |
| | | (15.42) | (16.92) | (7.102) | (7.692) | (5.578) | (6.235) |
| | Emotional | 41.88‡ | 40.04 | 18.66‡ | 21.55‡ | 7.755 | 8.417 |
| | | (22.15) | (26.14) | (10.07) | (11.77) | (7.697) | (9.144) |
| Interaction terms | slim * Ext | | -61.26 | | -12.77 | | -37.08† |
| | | | (59.09) | | (27.91) | | (18.86) |
| | slim * Emot | | 12.25 | | -10.85 | | 0.237 |
| | | | (44.42) | | (20.96) | | (14.53) |
| | slim * Rest | | 1.690 | | 13.44 | | 11.02 |
| | | | (38.95) | | (19.04) | | (12.00) |
| Food away from home | | 0.56 | 0.56 | 0.53 | 0.53 | -0.04 | -0.03 |
| | | (0.74) | (0.74) | (0.32) | (0.32)‡ | (0.25) | (0.25) |
| Time on activities | Hard | 1.28 | 1.27 | 0.42 | 0.42 | 0.17 | 0.16 |
| (hours) | | (0.38)* | (0.38)* | (0.15)* | (0.15)* | (0.11) | (0.12) |
| | Moderate | 0.54 | 0.54 | 0.18 | 0.18 | 0.02 | 0.02 |
| | | (0.24)† | (0.24)† | (0.11)‡ | (0.11)‡ | (0.08) | (0.08) |
| | Light | 0.16 | 0.16 | 0.02 | 0.02 | -0.02 | -0.03 |
| | | (0.23) | (0.23) | (0.10) | (0.10) | (0.07) | (0.07) |

*Table 2 contd…*

| Variable | Variable names | All sources | | Fats | | Sugars | |
|---|---|---|---|---|---|---|---|
| | | Slim Inter' | No inter | Slim Inter' | No inter | Slim Inter' | No inter |
| Education level (descending order) | Other qualifications | -102.65 | -99.47 | -22.96 | -22.85 | -36.08 | -34.46 |
| | | (79.33) | (79.66) | (35.05) | (35.20) | (23.10) | (23.12) |
| | GCSE Grades D-E or equivalent | 20.48 | 18.52 | 11.15 | 10.65 | 9.21 | 8.02 |
| | | (57.85) | (58.06) | (23.68) | (23.73) | (22.54) | (22.52) |
| | GCSE Grades A-C or equivalent | -2.19 | -1.20 | -5.24 | -5.27 | 4.31 | 4.74 |
| | | (42.66) | (42.72) | (18.90) | (18.92) | (14.89) | (14.84) |
| | GCE A level of equivalent | 41.40 | 42.06 | -0.55 | -0.82 | 20.68 | 20.78 |
| | | (50.10) | (50.11) | (22.21) | (22.26) | (16.88) | (16.89) |
| | Higher education below degree | 32.26 | 34.22 | -2.59 | -1.99 | 19.38 | 20.68 |
| | | (50.71) | (50.86) | (21.54) | (21.60) | (18.46) | (18.49) |
| | Degree or equivalent | 56.96 | 58.11 | 6.26 | 6.06 | 28.91 | 29.36 |
| | | (46.72) | (46.75) | (21.07) | (21.03) | (16.64)‡ | (16.57)‡ |
| Income | Income | 0.03 | 0.03 | 0.01 | 0.01 | 0.01 | 0.01 |
| | | (0.01)* | (0.01)* | (0.00)* | (0.00)* | (0.00)† | (0.00)* |
| | Income square | -0.00 | -0.00 | -0.00 | -0.00 | -0.00 | -0.00 |
| | | (0.00)* | (0.00)* | (0.00)* | (0.00)* | (0.00)† | (0.00)† |
| Household size | | -16.11 | -16.20 | -3.16 | -3.15 | -5.07 | -5.11 |
| | | (11.41) | (11.44) | (5.00) | (5.01) | (3.96) | (3.97) |
| Female | | -434.78 | -435.23 | -116.96 | -117.11 | -77.37 | -77.62 |
| | | (42.82)* | (42.99)* | (18.79)* | (18.85)* | (13.72)* | (13.74)* |

*Table 2 contd…*

| Variable | Variable names | All sources | | Fats | | Sugars | |
|---|---|---|---|---|---|---|---|
| | | Slim Inter' | No inter | Slim Inter' | No inter | Slim Inter' | No inter |
| Age | Age | 16.16 | 16.02 | 7.53 | 7.52 | 2.19 | 2.14 |
| | | (7.77)† | (7.80)† | (3.54)† | (3.54)† | (2.73) | (2.74) |
| | Age square | -0.13 | -0.13 | -0.06 | -0.06 | -0.01 | -0.01 |
| | | (0.09) | (0.09) | (0.04) | (0.04) | (0.03) | (0.03) |
| Height | | 11.25 | 11.23 | 4.71 | 4.72 | 1.24 | 1.24 |
| | | (2.13)* | (2.14)* | (0.92)* | (0.92)* | (0.71)‡ | (0.71)‡ |
| Constant | | -875.89 | -885.38 | -553.26 | -557.71 | 38.89 | 31.35 |
| | | (473.73)‡ | (474.50)‡ | (202.69)* | (203.02)* | (149.00) | (148.72) |
| Observations | | 1530 | 1530 | 1530 | 1530 | 1530 | 1530 |
| R-squared | | 0.419 | 0.420 | 0.323 | 0.323 | 0.180 | 0.183 |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1530. The three psychometric measures are jointly significant.

**Table 3:** Alternative specifications with different sets of potentially endogenous variables to tease out cross-correlation effects.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|---|---|---|---|---|---|---|---|---|---|---|
| Slim diet | -142.7* | -138.1* | -155.6* | -197.9* | -147.6* | -207.9* | -192.7* | -186.9* | | |
| | (32.90) | (32.89) | (33.07) | (31.02) | (33.36) | (31.01) | (30.77) | (30.89) | | |
| External | 123.7* | 143.0* | | 120.2* | | | 130.8* | | | 130.5* |
| Impulsivity | (25.66) | (22.73) | | (25.77) | | | (22.21) | | | (24.21) |
| Restraint | -62.34* | -56.69* | -59.29* | | -40.36* | | | | | -87.06* |
| | (15.86) | (15.47) | (16.02) | | (15.34) | | | | | (14.69) |
| Emotional | 38.54‡ | | 92.87* | 20.01 | | 73.74* | | | | 31.77 |
| Impulsivity | (22.23) | | (19.81) | (21.99) | | (19.02) | | | | (22.66) |
| *Activities* | | | | | | | | | | |
| Hard | 1.296* | 1.291* | 1.342* | 1.254* | 1.349* | 1.301* | 1.253* | 1.318* | 1.291* | 1.297* |
| | (0.409) | (0.412) | (0.405) | (0.411) | (0.411) | (0.407) | (0.412) | (0.411) | (0.412) | (0.279) |
| Moderate | 0.623† | 0.616† | 0.678* | 0.609† | 0.682* | 0.663* | 0.605† | 0.670* | 0.630† | 0.603* |
| | (0.251) | (0.252) | (0.252) | (0.252) | (0.255) | (0.254) | (0.253) | (0.256) | (0.258) | (0.231) |
| Light | 0.254 | 0.255 | 0.309 | 0.244 | 0.339 | 0.298 | 0.245 | 0.327 | 0.289 | 0.237 |
| | (0.232) | (0.233) | (0.234) | (0.234) | (0.237) | (0.236) | (0.234) | (0.238) | (0.239) | (0.219) |
| Constant | -1034.9† | -1031.5† | -846.4‡ | -1087.1† | -745.0 | -901.2‡ | -1082.7† | -800.2 | -795.0 | -1003.2† |
| | (485.4) | (486.5) | (487.3) | (489.1) | (494.8) | (490.4) | (489.8) | (496.1) | (502.9) | (447.2) |
| R-squared | 0.403 | 0.402 | 0.392 | 0.397 | 0.384 | 0.387 | 0.397 | 0.381 | 0.368 | 0.397 |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1466.

**Table 4:** Estimates on residuals from the equation of calories on physical activity.

| **Variables** | **Total Calories** | **Fat** | **Sugar** |
|---|---|---|---|
| On Slim diet | -141.74 | -58.68 | -55.18 |
| | (33.56)* | (14.82)* | (11.22)* |
| ***External Impulsivity*** | 113.3* | 56.04* | 24.46* |
| | (23.53) | (10.61) | (8.116) |
| ***Restraint*** | -66.14* | -46.70* | -13.65† |
| | (15.78) | (7.185) | (5.570) |
| ***Emotional Impulsivity*** | 45.28† | 20.05† | 8.443 |
| | (22.46) | (10.16) | (7.720) |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1530.

**Table 5:** Regression estimates for the different weight categories classified by BMI.

| **Variables** | **All sources** | | | **Fats** | | | **Sugars** | | |
|---|---|---|---|---|---|---|---|---|---|
| | Normal wt. | Over wt. | Obese | Normal wt. | Over wt. | Obese | Normal wt. | Over wt. | Obese |
| Slim diet | -129.0† | -106.6‡ | -165.6† | -38.87 | -34.71 | -89.88* | -93.75* | -44.93† | -27.20 |
| | (62.25) | (60.77) | (66.61) | (26.66) | (26.21) | (28.85) | (19.68) | (20.61) | (26.17) |
| External | 107.2* | 157.1* | 122.5‡ | 63.70* | 87.06* | 37.54 | 1.144 | 36.61† | 31.29 |
| Impulsivity | (40.86) | (45.56) | (66.51) | (17.87) | (19.90) | (28.08) | (13.39) | (16.76) | (24.93) |
| Restraint | -26.55 | -98.81* | -80.87‡ | -34.44* | -63.20* | -34.42 | 1.334 | -16.69 | -32.18† |
| | (22.15) | (31.54) | (44.94) | (9.991) | (13.94) | (21.70) | (8.072) | (12.14) | (14.35) |
| Emotional | 17.10 | 18.73 | 59.27 | -9.813 | 13.35 | 40.03† | 21.02 | -2.042 | 13.14 |
| Impulsivity | (40.66) | (35.54) | (51.55) | (18.06) | (16.36) | (19.93) | (13.77) | (12.77) | (18.41) |
| Constant | -975.6 | -1854.5† | 349.4 | -808.4* | -712.3‡ | 186.1 | 195.3 | -212.3 | 136.7 |
| | (720.1) | (894.8) | (1192.5) | (297.7) | (416.2) | (485.5) | (232.5) | (284.4) | (358.1) |
| Observations | 636 | 497 | 298 | 636 | 497 | 298 | 636 | 497 | 298 |
| R-squared | 0.381 | 0.435 | 0.379 | 0.268 | 0.353 | 0.335 | 0.163 | 0.163 | 0.102 |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. Classification based on BMI was as follows: Underweight (<18.5); Normal (18.5 – 24.9); Overweight (25.0 – 29.9); Obese (≥30.0).

**Table 6:** Regression estimates after exclusing low calories respondents.

| | **All sources** | | | **Fats** | | | **Sugars** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total Calories >>** | >500 | >1000 | >1200 | >500 | >1000 | >1200 | >500 | >1000 | >1200 |
| Slim diet | -144.7* | -139.2* | -97.66* | -61.38* | -57.46* | -40.33* | -55.62* | -54.32* | -47.84* |
| | (32.79) | (31.87) | (32.35) | (14.73) | (14.68) | (15.24) | (11.26) | (11.49) | (12.06) |
| External | 124.9* | 121.4* | 113.4* | 64.16* | 63.51* | 63.89* | 25.30* | 25.30* | 23.89† |
| Impulsivity | (25.61) | (25.38) | (25.39) | (11.64) | (11.69) | (12.02) | (9.154) | (9.264) | (9.457) |
| Restraint | -58.77* | -53.53* | -57.11* | -42.64* | -41.44* | -42.79* | -13.30† | -13.92† | -15.34† |
| | (15.77) | (15.63) | (15.65) | (7.319) | (7.405) | (7.504) | (5.843) | (5.979) | (6.097) |
| Emotional | 36.50 | 17.43 | 8.603 | 16.53 | 10.23 | 6.060 | 6.643 | 3.573 | 1.065 |
| Impulsivity | (22.21) | (21.87) | (22.28) | (10.06) | (10.07) | (10.27) | (7.760) | (7.867) | (8.184) |
| Constant | -1064.9† | -926.4‡ | -911.2‡ | -634.3* | -602.0* | -627.3* | 18.96 | 69.87 | 92.80 |
| | (484.2) | (482.0) | (485.3) | (206.8) | (208.9) | (215.0) | (155.4) | (158.8) | (162.5) |
| Observations | 1463 | 1415 | 1341 | 1463 | 1415 | 1341 | 1463 | 1415 | 1341 |
| R-squared | 0.401 | 0.394 | 0.374 | 0.300 | 0.287 | 0.263 | 0.154 | 0.139 | 0.113 |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request.

**Table 7:** Regression estimates after excluding low calorie and high calorie respondents.

| | **All sources** | | | **Fats** | | | **Sugars** | | |
|---|---|---|---|---|---|---|---|---|---|
| **Total Calories >>** | <4000 | <3500 | 500 - 3500 | <4000 | <3500 | 500 - 3500 | <4000 | <3500 | 500 - 3500 |
| Slim diet | -147.8* | -146.4* | -148.5* | -63.16* | -62.74* | -63.44* | -57.10* | -55.97* | -56.46* |
| | (32.78) | (32.57) | (32.47) | (14.73) | (14.61) | (14.61) | (11.11) | (11.08) | (11.08) |
| External | 117.4* | 124.4* | 125.6* | 59.51* | 63.73* | 64.20* | 23.99* | 24.93* | 25.06* |
| Impulsivity | (24.06) | (23.66) | (23.59) | (10.76) | (10.45) | (10.44) | (8.468) | (8.470) | (8.473) |
| Restraint | -46.04* | -44.89* | -41.19* | -37.12* | -37.37* | -36.25* | -8.301 | -8.027 | -7.442 |
| | (14.87) | (14.57) | (14.43) | (6.980) | (6.815) | (6.806) | (5.346) | (5.330) | (5.342) |
| Emotional | 32.49 | 27.14 | 25.02 | 15.39‡ | 12.37 | 11.70 | 4.856 | 4.525 | 4.169 |
| Impulsivity | (20.66) | (20.45) | (20.43) | (9.272) | (9.161) | (9.158) | (7.490) | (7.450) | (7.451) |
| Constant | -1105.3† | -976.5† | -1007.1† | -644.1* | -606.0* | -613.5* | 6.190 | 32.78 | 28.35 |
| | (446.2) | (438.8) | (437.6) | (189.5) | (187.4) | (187.3) | (148.1) | (146.9) | (146.9) |
| Observations | 1457 | 1446 | 1443 | 1457 | 1446 | 1443 | 1457 | 1446 | 1443 |
| R-squared | 0.403 | 0.401 | 0.399 | 0.296 | 0.293 | 0.290 | 0.149 | 0.147 | 0.145 |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request.

**Table 8:** Quantile regression estimates of total calories.

| **Quantiles >>** | **0.10** | **0.25** | **0.50** | **0.75** | **0.90** |
|---|---|---|---|---|---|
| On Slim diet | -120.28 | -170.03 | -121.70 | -92.38 | -78.54 |
| | (57.05)† | (43.76)* | (37.18)* | (37.62)† | (67.13) |
| ***External Impulsivity*** | 103.4* | 99.54* | 117.9* | 134.2* | 173.3* |
| | (35.63) | (26.38) | (21.92) | (23.73) | (44.81) |
| ***Restraint*** | -44.50‡ | -32.22‡ | -48.00* | -79.08* | -107.1* |
| | (25.63) | (18.57) | (15.54) | (16.25) | (29.39) |
| ***Emotional Impulsivity*** | 44.35 | 53.36† | 27.36 | 32.86 | -13.48 |
| | (36.16) | (27.01) | (22.88) | (24.74) | (45.60) |
| Food bought or brought | 1.27 | 1.19 | 1.09 | 1.08 | -0.03 |
| away from home (%) | (1.25) | (0.94) | (0.74) | (0.72) | (1.36) |
| Hard activities (min) | 0.94 | 0.98 | 0.85 | 1.57 | 2.74 |
| | (0.45)† | (0.32)* | (0.27)* | (0.28)* | (0.51)* |
| Moderate activities (min) | 0.31 | 0.41 | 0.52 | 0.93 | 0.05 |
| | (0.41) | (0.28) | (0.23)† | (0.22)* | (0.43) |
| Light activities (min) | 0.11 | 0.17 | 0.21 | 0.62 | -0.35 |
| | (0.39) | (0.27) | (0.21) | (0.22)* | (0.42) |
| Constant | -1,198.98 | -1,038.29 | -1,109.87 | -1,800.11 | 694.97 |
| | (727.40)‡ | (554.73)‡ | (450.34)† | (455.00)* | (860.71) |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1530. Bootstrapped with 100 replications.

**Table 9:** Quantile regression estimates of calories from sugars.

| **Quantiles >>** | **0.10** | **0.25** | **0.50** | **0.75** | **0.90** |
|---|---|---|---|---|---|
| On Slim diet | -26.75 | -41.77 | -59.74 | -50.67 | -25.97 |
| | (14.95)‡ | (15.00)* | (14.69)* | (14.72)* | (25.09) |
| ***External Impulsivity*** | 11.34 | 12.44 | 17.65† | 39.44* | 48.77* |
| | (8.051) | (8.910) | (8.788) | (6.793) | (15.74) |
| ***Restraint*** | 1.086 | -5.602 | -14.74† | -18.99* | -25.83† |
| | (6.317) | (6.330) | (6.246) | (4.989) | (11.21) |
| ***Emotional Impulsivity*** | 11.82 | 10.58 | 18.18† | 6.709 | 10.39 |
| | (8.755) | (9.178) | (9.199) | (7.124) | (17.49) |
| Food bought or brought | 0.43 | 0.18 | 0.38 | 0.07 | -0.16 |
| away from home (%) | (0.32) | (0.31) | (0.29) | (0.28) | (0.49) |
| Hard activities (min) | 0.14 | 0.14 | 0.26 | 0.20 | 0.26 |
| | (0.12) | (0.11) | (0.11)† | (0.11)‡ | (0.19) |
| Moderate activities (min) | -0.04 | -0.01 | 0.10 | 0.06 | -0.20 |
| | (0.10) | (0.09) | (0.09) | (0.09) | (0.14) |
| Light activities (min) | 0.03 | 0.01 | 0.09 | 0.03 | -0.23 |
| | (0.10) | (0.09) | (0.09) | (0.08) | (0.13)‡ |
| Constant | 5.59 | 16.77 | -120.33 | -111.95 | 186.39 |
| | (178.80) | (176.92) | (178.15) | (177.38) | (289.41) |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1530. Government regions were excluded because iterations did not converge.

**Table 10:** Quantile regression estimates of calories from fats.

| **Quantiles >>** | **0.10** | **0.25** | **0.50** | **0.75** | **0.90** |
|---|---|---|---|---|---|
| On Slim diet | -76.21 | -53.20 | -63.34 | -56.75 | -52.98 |
| | (20.70)* | (20.59)* | (20.77)* | (18.90)* | (28.75)‡ |
| ***External Impulsivity*** | 52.26* | 56.73* | 45.40* | 72.31* | 55.75* |
| | (14.02) | (12.60) | (12.53) | (11.61) | (17.66) |
| ***Restraint*** | -42.86* | -47.63* | -42.15* | -36.56* | -57.11* |
| | (9.377) | (8.979) | (8.900) | (8.135) | (13.67) |
| ***Emotional Impulsivity*** | 35.24† | 18.40 | 19.18 | 7.727 | 5.234 |
| | (14.03) | (13.08) | (13.17) | (12.32) | (18.21) |
| Food bought or brought | 0.45 | 1.42 | 0.79 | 0.53 | -0.24 |
| away from home (%) | (0.46) | (0.43)* | (0.41)‡ | (0.37) | (0.55) |
| Hard activities (min) | 0.03 | 0.13 | 0.44 | 0.51 | 0.91 |
| | (0.17) | (0.15) | (0.15)* | (0.14)* | (0.22)* |
| Moderate activities (min) | -0.01 | 0.03 | 0.24 | 0.37 | 0.28 |
| | (0.15) | (0.13) | (0.13)‡ | (0.12)* | (0.17) |
| Light activities (min) | -0.11 | -0.06 | 0.13 | 0.15 | 0.06 |
| | (0.14) | (0.13) | (0.12) | (0.11) | (0.17) |
| Constant | -455.64 | -414.34 | -670.12 | -829.53 | -455.50 |
| | (277.37) | (261.73) | (251.05)* | (229.55)* | (351.45) |

Note: Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%. Full model estimates are available upon request. N=1530.

# CHAPTER 3: NUTRITION-LABEL INFORMATIONAL CAMPAIGN EFFECTS OF THE NUTRITION LABELING AND EDUCATION ACT OF 1990 (NLEA) ON DIETARY OUTCOMES

## Introduction

Increasing diet-health awareness among consumers, particularly in the 1980s, created a need for consistent, usable and understandable nutrition information on food products to help consumers make more informed choices. The Nutrition Labeling and Education Act of 1990 (NLEA) was proposed to address these concerns. Important changes included standardized label format across food products, specified comparable serving sizes by food product category, and listed percent daily values. Percent daily value is the percent of specific nutrient in a standardized serving for an individual with a 2,000 calorie-per-day requirement. Although the NLEA primarily focused on standardizing nutrition facts label, its implementation also involved an informational campaign on how to use the new nutrition facts panel (NFP) and its benefits.

Most of the existing literature on NLEA has studied the impacts of the standardization of labels but have largely ignored the campaign effects on dietary outcomes. The standardization of nutrition labels was indeed the more important part of NLEA, but effective communication was key to informing citizens on how to use the information presented in the NFP. The primary objective of this paper is to fill this gap in the literature by estimating the effects of the campaign on dietary outcomes. Evaluating the nutrition benefits of such programs can lead to improvement in consumer health by guiding communication or campaign of future nutrition policies, as well as help policymakers determine benefits of expending on public policies and programs. Implementing and overseeing NLEA cost the government an estimated $163 million.

Since NFP is the only source of nutrition information available at the point-of-purchase, prodigious efforts were undertaken to increase public awareness of the new nutrition label among consumers and to teach them to read the nutrition label to make informed choices. The nutrition-label informational campaign involved propagating information via the news media, including TV networks and newspapers, and through various public health and nutrition agencies at the county, state and national levels (van Wagner, 1994; Kurtzweil, 1994). One major multi-year initiative was titled “The New Food Label – Check It Out,” which was a slogan to appear in different avenues as an informational campaign to prompt consumers to check out the new food label. The slogan appeared in the New York Time Square ticker, three Goodyear blimps, and others. This initiative was jointly headed by the Department of Health and Human Services, the FDA, and the Food Safety and Inspection Service of the Department of Agriculture (Kulakow, 1995).

Research on standardization of labels has, in general, found positive effects of both the comprehension of the new labels and in its impact on healthful choices (Satia, Gelanko and Neuhouser, 2005). Calories from fat, saturated fat and cholesterol was lower among label users (Kreuter et al, 1997; Neuhouser, Kristal and Patterson, 1999; Temple et al, 2010). Most studies evaluate the impact of label-use using correlations, regression adjusted associations, or analysis of covariance. Only two studies explicitly address the self-selection of label use to estimate its impact on dietary outcomes.

Kim, Nayga and Capps (2000) used switching regression method that relies on proper model specification of the selection equation. They do not specifically identify a variable that might be exogenous in the nutrient-intake equation. Variyam (2008) used the absence of nutrition labels in the food away from home as the identification strategy. This strategy has an attractive feature of not relying on exclusion restrictions. While nutrition information was required for most of the packaged foods and was required to be prominently displayed at the point of unpackaged foods, it was absent for food prepared and consumed outside (Shapiro, 1995).

In this paper, I employ the difference-in-difference (DID) strategy used by Variyam (2008) to study consumer response to mass-media informational campaign undertaken as part of NLEA. I exploit time and spatial variation in the nutrition-label information dissemination. Media variables are constructed, using concepts from media and education literature, to estimate the influence of newspaper media on dietary outcomes.

Below I briefly discuss NLEA and the media campaign followed by media variable, methods and discussion of results.

**Brief History of the NLEA and the Media Campaign**

It was, perhaps, no coincidence that the drafting of the NLEA followed the period of growing influence of economics of (imperfect) information, particularly led by Stiglitz in the 1980s. Earlier economic work also recognized the role and cost of obtaining information (Stigler, 1961). Becker's (1965) economic model incorporated time as a valued commodity that influences consumption. In situations where obtaining information is costly, government interventions to provide information could make everyone better off. Nutrition information in products is considered a credence characteristic (Aldrich, 1999). According to Aldrich, this characteristic implies consumers need to verify the information from sellers and third parties. Therefore consumers are better off if a more responsible and accountable institution oversees the provision of information. Government intervened in the market to provide information at the point of purchase which reduced the time and cost of obtaining information.

Food labeling, based on the regulations of the Food and Drug Administration (FDA) in 1973, was voluntary, but mandatory if fortified by proteins, minerals or vitamins. The NLEA enacted in 1990 was the next major step which required all processed food products to display standardized nutrition information. As a result, 96% of the processed foods had nutrition labels in 1996, an increase from about 60% in 1990 (Brecher et al, 2000).

Before the NLEA was in effect in 1994, the nutrition label carried information on calories from carbohydrates, fats and the whole product, and grams of protein in a non-standardized serving size. The NLEA required NFP to have information on the amount of calories from an entire serving (total), and from fats, saturated fats, and cholesterol in a standardized serving size, and servings per package [12]. Calories were to be in amount and percent of reference daily intake for a 2000-calorie diet.

[12] Other information such as, sodium is not discussed here.

By law, the NLEA required that the labeling changes be accompanied by an educational campaign. Prodigious efforts were undertaken, millions spent, and media publishing were asked to propagate information on both the benefits from using and how to use. Public health agencies at Federal, State and local levels were to inform and educate the public on the NFP. The FDA made efforts to publicize NFP in newspapers, TVs, and also during football games. For example, one TV spot (ad) focused on the importance of good nutrition in promoting good health (30-second version), and another spot featured Kirby Puckett of the Minnesota Twins, Roger Clemens of the Boston Red Sox with the Health and Human Services (HHS) Secretary, Donna Shalala[13]. This was not to educate people on the labels but just to encourage consumers to use the labels. Moorman (1996) found that consumers acquired and comprehended more nutrition information from the new labels.

**Media**

Below I discuss the importance of media on consumption decisions, and also describe media variables.

*Newspapers and TV networks as sources of information*

Television and newspapers offer a trusted avenue for obtaining news and other information (Frewer et al, 1996). Among the media sources, based on survey results from the Nationwide Food Consumption Survey conducted by USDA in 1987-88, newspaper was considered one of the most important health information sources[14].

The type of information, whether positive or negative, also influences individual decisions and choices (Mutondo and Henneberry, 2007). Fox, Hayes and Shogren (2002) showed, in an experimental setting, how favorable and unfavorable information affect willingness-to-pay for pork treated by irradiation to control parasite, Trichinella. When both positive and negative

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[13] Source: http://www.fda.gov/NewsEvents/Speeches/ucm106534.htm

[14] U.S. Department of Agriculture, 1987-88, Nationwide Food Consumption Survey, Household Portion.

information were presented at the same time, the negative information effect dominated. This was true even after revealing the source of negative information as being a consumer advocacy group. The information was written in a non-scientific manner. The results were robust each of the four times the experiment was carried out.

I use newspaper information as the media campaign instrument. The newspaper data has variation at the level of metropolitan and non-metropolitan statistical areas, as defined by the Office of Management and Budget (OMB). Newspapers are considered a more important source of newer concepts since newspaper gives the reader enough time to read and grasp to be able to use in decision-making. Newspapers have a wider reach among Americans and also a cheaper source for disseminating information.

*Media Variable*

Research has shown that demographic characteristics, such as age, education, race, gender and income; interest in the subject; and cognitive styles, both cognitive skills and cognitive strategies have an impact on learning (Mendelson and Thorson, 2004). Cognitive skills include comprehension. According to education theory on text comprehension, there is heterogeneity of reader processing. The dataset has no information on cognitive styles, but other variables such as education and age play a role on cognition and these are included in the model. In this paper three types of media variables are constructed to measure the impact of newspapers on dietary outcomes, which are described below.

*Number of news articles*: The first media variable is the aggregate number of articles on nutrition labels by MSA. News articles published in an area do not indicate the exposure to an article. So I weight each article by a circulation factor of the respective newspaper. Circulation factor for any newspaper in an MSA is the annual (12 monthly average) net paid percentage of non-institutionalized households that subscribed to it. Circulation factor is assumed to indicate the possibility of having read the article.

*Type of information*: Information theory suggests that negative information is perceived differently from positive information, and that their influence on decision or outcome is also of different magnitudes. So each article is classified as positive or negative based on the article content. Media studies on some aspects of foods suggest that classifying positive and negative information could be subjective (Mazzochi, 2004). In this study, however, there was less ambiguity or subjectivity in classifying an article as positive or negative. News article that portrayed label as confusing, inconsistent and not useful or discredit the label information are deemed negative and is less subject to judgment. If the article simply explains the type of information available in the nutrition label and how to use it, it is considered positive. Out of the 140 articles, 67 were considered positive and 8 were considered negative.

*Depth of article*: Some articles on nutrition make a passing comment on nutrition labels, while others explain the nutrition label in detail. So another dummy variable is created to indicate if the article is detailed or not. Some of the newer aspects introduced in the nutrition label were percent daily values and standardized serving sizes. Any article that describes daily values and standardized serving size especially with an example is considered "detailed." About 50 were considered detailed, and six of them were negative.

Below I give two examples of articles that were used to create media variables. The following article was rated positive but labeled "not detailed." The article[15] was titled, "There Are No 'Bad' Foods" with a description, "use the NFP on the new food label to help determine how much fat is in different foods. Use this information to balance your food choices."

Some articles portrayed NFP as confusing, not useful or made other negative remarks, which were rated as negative. All the others were rated positive. An example of a negative article[16] had a title "Nutrition Labels May Spur Bad Food Choices, Study Says."

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[15] Published on Tuesday, April 9, 1996, written by Michele Murphy Wise, and Barbara Zonakis in page D2 in the Section Health & Fitness in the newspaper Post-Tribune (IN.)

[16] Published on Monday, October 16, 1995, written by Paul Raeburn in page 5-B in the newspaper The Advocate (Baton Rouge, LA.)

## Methods

The primary objective in this study is to estimate the impacts of the informational campaign of NLEA on dietary outcomes. So each of the nutrients listed on NFP is regressed on covariates that might influence it. Label use and media variables are of primary interest. Difference news publishing dates and date of food record across MSAs give time and spatial variation in the media content information dissemination. A person who uses labels or reads nutrition information could be someone who is more interested in nutrition. Therefore label use and media variable cannot not be considered exogenous in an equation with dietary choice as the outcome variable. Even though variables that ask for importance of nutrition, taste, and price is included in the model, there could be some unobserved characteristics or ability that might be correlated with label use and media variable.

A difference-in-difference strategy is employed to difference out these unobservables. Variyam (2007) used the exemption of food-away-from-home (FAFH) from labeling requirement as the identification strategy. The food-at-home (FAH) include food purchased from store, vending machines and via mail order. The rest of the food products were considered unlabeled which included food from restaurant, fast food/pizza, bar, tavern, lounge, school cafeteria, other cafeteria, care center, soup kitchen, meals on wheels, via other programs, animals grown or caught, gift from someone else, common pot or tray, residential facility, breast milk/water as ingredient, and fish caught.

Although fresh foods are not all labeled individually, the NLEA required grocers to display nutrient information by the produce. Since NFP was required only for packaged processed foods, the consumers see the nutrition information only for those food products. The FAFH is exempt from mandatory labeling and thereby serve as a control group of food products while the FAH, which has NFP, would serve as the treatment group of food products. Each nutrient can be obtained from FAFH and FAH, which could formally be written as two different equations. Differencing the two equations, for each nutrient, would remove unobserved factors that might be correlated with the media and label use variables.

The econometric specification for nutrient intake or dietary outcome is described below.

Equation 1: $\boldsymbol{y_{Hi} = \beta_{H0} + \beta_{H1}L + \beta_{H2}M + \beta_{H3}X + \eta_i + \varepsilon_{Hi}}$,

where, $y_i$ denotes the quantity of the specified nutrient in the individual *i*'s diet. Each of the nutrients, listed in the NRP is analyzed separately. Subscript *H* denotes labeled foods; *L* stands for label use; *M* is the media variable; *X* is a vector of demographic and other variables; $\eta$ is the individual level unobserved characteristics; and the last term is the idiosyncratic normal error term. Equation for the FAFH is specified as:

Equation 2: $\boldsymbol{y_{Ai} = \beta_{A0} + \beta_{A1}L + \beta_{A2}M + \beta_{A3}X + \eta_i + \varepsilon_{Ai}}$,

where, subscript *A* stands for FAH; and all else are the same as in equation 1. Differencing equation 2 and 3 removes all unobserved factors, especially those that influence both in similar magnitudes. The modified equation is

$$\Delta y_i = \gamma_0 + \gamma_1 L + \gamma_2 M + \gamma_3 X$$

where the coefficient of the label use variable, $\gamma_2$, is now the effect of the media variable after differencing out the unobserved factors influencing dietary outcomes and potentially correlated with media variables. In this paper, I run individual equations and then take the difference between the estimates of media variables. One caveat of using DID is that these estimates are consistent only if the unobserved factors for both FAFH and FAH are similar. There could be factors that influence FAFH and FAH differently.

One of the challenges in modeling FAFH is that about 19 percent of the respondents reported no FAFH consumption. Variyam (2008) used Heckman selection but the inverse mills ratio was not significant in most of the nutrients, and the Wald-test statistics also do not support using it. So I prefer to use Tobit model so as to obtain comparable estimates, which has been used to account for zero nutrient intake (Chandran, 2004; and Heien and Wessells, 1990). Furthermore, there are no instruments that affect choice of FAFH but not dietary outcomes.

I integrate MSA and non-MSA information of the respondents and newspaper articles discussing nutrition labels give time and spatial variation to measure the impact of informational campaign on nutrient intake.

## Data

The datasets used are the CSFII conducted in 1994-96, the HEI constructed by the CNPP, and the newspaper database maintained by Acess World NewsBank.

CSFII and the Diet and Health Knowledge Survey (DHKS) were two nationwide surveys conducted by Agricultural Research Service (ARS), USDA during 1994-96. These surveys were designed to measure the different types of food and their respective amounts eaten by Americans as well as their attitudes and knowledge about diet and health. The DHKS was the first national survey of attitudes and knowledge on diet and health. The target population of these surveys was noninstitutionalized individuals in all 50 states and Washington, DC.

In each of the three survey years, 1994-96, the sample of individuals were "asked to provide food intakes for two non-consecutive days through the administration of in-person, 24-hour dietary recalls spaced 3-10 days apart." The above formed the CSFII database. DHKS was administered to one adult from each of the CSFII household of at least 20 years old who had participated in at least one of the two days of survey. The overall average day-1 and day-2, response rates were 80.0 and 76.1 %, respectively. The overall average DHKS response rate was 73.5 %. Of the total sample persons completing day-1 (total of 16,103) and day-2 (total of 15,303), a sample of 5765 participated in the DHKS.

CSFII contains information on serving sizes of the different food categories and not calories. The amount of calories from these food groups is the product of serving sizes and the average calories obtained from it.

The DHKS includes people of 20 years or above and therefore this analysis is limited to this age group. Table 11 shows averages for the various covariates used in the econometric models. Several other variables were included such as, employment, year of survey (1994-1996), region, age, race, gender, urbanization of the residence place, and height of respondents. Most of the regressors were dummy variables except for age, household size, income, and height. One variable to control for the caloric needs of a person but still not endogenous, i.e., predetermined, was the height. Body Mass Index (BMI) includes both height and weight which renders it unsuitable because of potential endogeneity of the weight variable, by way of reverse causality.

These variables account for several factors that could potentially alter or affect caloric needs as found in the literature. A variable indicating different levels of exercise was included to control for the extra energy expenditure due to physical activity levels. Individuals performing intensive physical activity could be consuming higher proportion of proteins and fats. This variable is discrete and the value is ranked in the descending order of the intensity of exercise. A mean of 3.9 indicates that the activity level was close to once a week in the sample. But standard error was about two points for a mean of about 4 points implying high variability within the sample.

The Centre for Nutrition Policy and Promotion (CNPP), USDA constructed the Healthy Eating Index (HEI) to measure the healthfulness of the diet of individuals based on the macronutrient composition in their diet in adherence to the dietary guidelines. The HEI is constructed using nutrition information in the respective datasets. A higher score implies a better diet or a healthier diet. Other than HEI, I use the proportion of calories from fats, as other indicators of diet quality.

*Newspaper Database*

The NLEA campaign started in the year 1993 when the format of NFP was signed into effect by President George Bush. I needed newspaper articles published on NFP during the informational campaign period by metropolitan or non-metropolitan statistical areas. Access NewsBank has the news article details, including the name of the newspaper, and the entire article. Circulation, an annual publication of circulation figures, had information of individual newspapers published by statistical areas. These two together made up the news and circulation database, which was then matched with the respective geographic areas of each respondent in the Continuing Survey of Food Intakes of Individuals (CSFII).

The following criteria were applied to select articles during the period January 1993 through December 1996. Only articles that had the word "nutrition" in the lead paragraph, and keywords “nutrition information,” “nutrition label,” or “nutrition facts” anywhere in the article were selected. Out of the total of 369 news articles, only 140 were chosen that were published in the geographic areas where the CSFII survey respondents resided.

Only 40% (25 out of 62) of the goegraphic areas had newspapers publishing companies or agencies publish any article with the above criteria. This translated into 30% of respondents who might have read any such newspaper article. Any article that discussed any of the aspects of the new NFP with the above criteria was included. Some articles that were not counted included those that discussed recipes, nutrient claims (low fat, for example), or nutrition workshop announcements.

**Results**

In this section, I discuss the results for labeled and unlabeled products separately. The nutrient intakes were expressed as quantities per 1,000 calories of total energy, i.e., nutrient density, except for the total energy intake which was expressed as calories per kilogram of food, i.e., energy density. OLS and tobit estimates are similar for labeled products since less than one percent reported zero food products purchased from the store, vending machine or ordered via mail order. But the OLS and tobit estimates differed, although in smaller magnitudes, for unlabeled food products since there were about 20 percent who reported zero values for unlabeled food products. Below, I discuss the FAH (labeled) and FAFH (unlabeled) results, and the DID estimates of the media variable.

*Total media exposure*

The media variable is the circulation data for each of the articles summed up at primary sampling unit level, which is a metropolitan or non-metropolitan statistical area, as defined by OMB. Total circulation had a desirable negative effect on total fat, saturated fat intake, and cholesterol.

Total circulation did not influence nutrient consumption from unlabeled products but had a very small effect on sodium, sugar, and protein consumption from labeled foods (Tables 13 and 14).

As expected, protein was higher (0.008 gm per 1,000 calories) and sugars (0.003) were lower, but sodium (0.3) was slightly higher from labeled foods. Interestingly, there is some evidence that total circulation did reduce intake of saturated (0.004), total fats (0.012), and total energy (0.5), in very small amounts, from unlabeled products.

The DID estimates show a reduced saturated fat (0.7 gm) and calcium (18) intake, and higher carbohydrates (4) and fiber (0.8) intake from labeled products relative to the unlabeled products. The censor-corrected tobit estimates, however, showed only 0.7 gm reduced intake of saturated fat.

*Positive and Negative Media Exposure*

Articles that portrayed NFP as a tool for helping choose healthier increased sodium (1 gm) and protein (0.03) intake but reduced sugar (0.01) intake from labeled products (Tables 15 and 16). The positive articles had some desirable effects even from unlabeled products – lower intake from total fat (0.04), saturated fat (0.02), and total energy (1.7). The DID estimates showed reduced saturated intake (0.7) and increased carbohydrate intake (4) from labeled products relative to the unlabeled products.

Articles that portrayed NFP negatively did not impact nutrient consumption from labeled products, but it increased intakes of total fats (5 gm), sodium (206), protein (4.3), iron (1), and saturated fats (1.3) from unlabeled products (Tables 17 and 18). However, the DID estimates showed a positive effect only on fiber intake, in the amount of 0.8 gm per 1,000 calories.

**Conclusion**

In this study, I model the NLEA media campaign impacts of one of the most important nutrition public policies in America that provided nutrition information to consumers at the point-of-purchase. Tobit model is used to account for censoring, particularly for the 19 percent of the respondents who reported zero food-away-from-home intake.

The DID estimates showed that total meida circulation only reduced saturated fat intake from labeled products relative to unlabeled products. Total circulation slightly increased protein and sodium intake but decreased sugars intake from labeled foods. It is worth noting that total circulation reduced, although only in small amounts, total fat, saturated fat and total energy from unlabeled foods.

Similar impact was observed in the case of positive news articles for both the labeled and unlabeled products. One major reason was that a larger percentage of positive articles in the total circulation. Sodium intake from labeled products was, unexpectedly, higher in response to total media circulation and positive circulation - although in very small amounts. An important reason could be that sodium is used in packaged foods as a preservative, flavor enhancer and pH control agent, and an acidulant.

Surprisingly, negative news articles did not influence labeled but only unlabeled foods. It increased intakes of certain unhealthier nutrients including total fats, sodium, and saturated fats. The statistical insignificance of negative articles in the case of labeled foods also indicates that these articles did not create any difference among the respondents whenever nutrition label information was present. It might, however, have created a lax on foods that did not have nutrition information.

Limited campaign effects might be due to heavy focus on verbal communication rather than visual or pictorial. One of the reasons for such differences among individuals is that the educational campaign had not reached all people. For instance, Byrd-Bredbenner and Kiefer (2001) report that only one in three women recall receiving labeling education in any form. Allen (1995) found, using media content analysis, that the labeling information was insufficiently comprehensive to understand and use nutrition labels.

Future informational campaigns should incorporate theoretical concepts from media and education to communicate effectively. That is, considering cognitive styles, and cognitive skills in addition to the usual demographics, including education, age, ethnicity, etc. As suggested by Jonassen and Grabowski (1993), visual and verbal messages should have been used to better illustrate how to use information in NFP. That would have increased the chances of reading the articles. One study on newspaper readers, for example, that found that about 75 percent of all photos in the newspapers are “looked at” but only 25 percent of the text are (Garcia and Stark, 1991). Effective communication of credible nutrition information by reliable sources would improve consumer health.

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**Table 11:** Mean nutrient intakes of labeled and unlabeled food products by media exposure those listed on the Nutrition Facts Panel.

| **Nutrients** | **Unit per 1,000 calories** | **Labeled** | | | | **Unlabeled** | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | **Media** | | **No Media** | | **Media** | | **No Media** | |
| | | *Mean* | *SD* | *Mean* | *SD* | *Mean* | *SD* | *Mean* | *SD* |
| **Energy** | calories* | 959 | 358 | 960 | 324 | 986 | 895 | 954 | 823 |
| **Total Fat** | gm** | 36 | 11 | 35 | 11 | 32 | 22 | 32 | 21 |
| **Cholesterol** | gm | 136 | 103 | 134 | 106 | 118 | 172 | 119 | 153 |
| **Sodium** | gm | 1,727 | 654 | 1,704 | 700 | 1,398 | 1,282 | 1,459 | 1,300 |
| **Carbohydrates** | gm | 130 | 31 | 132 | 31 | 87 | 62 | 88 | 59 |
| **Protein** | gm | 39 | 13 | 40 | 13 | 32 | 26 | 32 | 24 |
| **Sat Fat** | gm | 12 | 5 | 12 | 5 | 10 | 8 | 10 | 8 |
| **Fiber** | gm | 9 | 5 | 9 | 6 | 7 | 9 | 6 | 8 |
| **Sugars** | gm | 6 | 6 | 6 | 5 | 5 | 8 | 6 | 8 |
| **Vit C** | mg** | 56 | 59 | 59 | 67 | 42 | 135 | 34 | 76 |
| **Vit A** | IU** | 3,979 | 5,575 | 4,170 | 6,455 | 3,323 | 14,591 | 2,987 | 12,441 |
| **Calcium** | mg | 387 | 218 | 390 | 198 | 267 | 389 | 281 | 303 |
| **Iron** | mg | 8 | 5 | 9 | 5 | 6 | 6 | 6 | 5 |

Note: About 1718 (31%) respondents were exposed to media and about 3,958 (69%) were not.
*Calories here is calories per 100 gram of food.
**gm stands for grams, mg for milligrams, and IU stands for International Units, which is equivalent to 0.3 microgram (mcg).

**Table 12:** Mean nutrient intakes of select nutrient intakes by type of media exposure.

| Nutrients | Unit per 1,000 calories | Labeled | | | | Labeled | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Positive | | Positive | | Positive | | Positive | |
| | | *Mean* | *SD* | *Mean* | *SD* | *Mean* | *SD* | *Mean* | *SD* |
| **Energy** | calories* | 961 | 325 | 947 | 309 | 965 | 830 | 853 | 726 |
| **Total Fat** | gm** | 35 | 11 | 33 | 12 | 32 | 21 | 32 | 20 |
| **Cholesterol** | gm | 135 | 108 | 122 | 84 | 120 | 155 | 120 | 131 |
| **Sodium** | gm | 1711 | 701 | 1627 | 695 | 1448 | 1179 | 1468 | 1074 |
| **Carbohydrates** | gm | 132 | 31 | 131 | 33 | 87 | 59 | 91 | 56 |
| **Protein** | gm | 40 | 13 | 40 | 15 | 32 | 24 | 34 | 24 |
| **Sat Fat** | gm | 12 | 5 | 12 | 6 | 10 | 8 | 11 | 8 |
| **Fiber** | gm | 9 | 6 | 9 | 4 | 6 | 8 | 6 | 7 |
| **Sugars** | gm | 6 | 5 | 5 | 6 | 6 | 8 | 6 | 9 |
| **Vit C** | mg** | 59 | 68 | 60 | 47 | 34 | 76 | 27 | 49 |
| **Vit A** | IU** | 4145 | 6550 | 4360 | 4773 | 3036 | 12859 | 2280 | 3644 |
| **Calcium** | mg | 388 | 199 | 422 | 183 | 278 | 303 | 326 | 272 |
| **Iron** | mg | 9 | 5 | 9 | 6 | 6 | 5 | 6 | 4 |

*Calories per 1,000 gram (= 1 kilogram) of food.
**gm stands for grams, mg for milligrams, and IU stands for International Units, which is equivalent to 0.3 microgram (mcg) for vitamin A.
Note: About 1718 (31%) respondents were exposed to media and about 3,958 (69%) were not.

**Table 13:** Difference-in-difference estimate (OLS) of total circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| **Nutrients** | **Lab** | | **Unlab** | | **DID*** | **p-val** |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | 0.0324 | (0.705) | -0.3540 | (0.101) | -19.509 | (0.50) |
| **Total Fat** | 0.0013 | (0.639) | -0.0096 | (0.069) | -1.132 | (0.17) |
| **Cholesterol** | 0.0349 | (0.168) | 0.0418 | (0.306) | 1.904 | (0.78) |
| **Sodium** | 0.2940 | (0.078) | -0.2320 | (0.461) | -10.544 | (0.84) |
| **Carbohydrates** | -0.0064 | (0.402) | -0.0093 | (0.533) | 3.890 | (0.07) |
| **Protein** | 0.0076 | (0.019) | -0.0034 | (0.589) | -0.704 | (0.51) |
| **Sat Fat** | 0.0008 | (0.481) | -0.0033 | (0.080) | -0.654 | (0.01) |
| **Fiber** | -0.0005 | (0.676) | -0.0014 | (0.514) | 0.795 | (0.04) |
| **Sugars** | -0.0029 | (0.042) | 0.0009 | (0.645) | 0.047 | (0.90) |
| **Vit C** | -0.0197 | (0.194) | -0.0051 | (0.852) | 3.298 | (0.36) |
| **Vit A** | -1.5760 | (0.275) | 2.7970 | (0.427) | 887.766 | (0.12) |
| **Calcium** | -0.0657 | (0.210) | -0.1060 | (0.248) | -18.201 | (0.10) |
| **Iron** | 0.0008 | (0.511) | -0.0013 | (0.337) | 0.346 | (0.18) |

Note: *DID estimates consider insignificant estimates as zeros.

**Table 14:** Difference-in-difference estimate (TOBIT) of total circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| Nutrients | Lab | | Unlab | | DID* | p-val |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | 0.0324 | (0.705) | -0.467 | (0.088) | -21.443 | (0.64) |
| **Total Fat** | 0.00134 | (0.620) | -0.0119 | (0.082) | -1.096 | (0.22) |
| **Cholesterol** | 0.0379 | (0.138) | 0.0331 | (0.544) | -1.153 | (0.89) |
| **Sodium** | 0.294 | (0.077) | -0.366 | (0.357) | -11.875 | (0.83) |
| **Carbohydrates** | -0.00637 | (0.401) | -0.0161 | (0.401) | 3.767 | (0.14) |
| **Protein** | 0.00765 | (0.018) | -0.00640 | (0.419) | -0.768 | (0.55) |
| **Sat Fat** | 0.00084 | (0.467) | -0.00430 | (0.079) | -0.648 | (0.09) |
| **Fiber** | -0.00048 | (0.699) | -0.00253 | (0.367) | 0.754 | (0.14) |
| **Sugars** | -0.00285 | (0.049) | 0.00052 | (0.847) | 0.033 | (0.94) |
| **Vit C** | -0.0178 | (0.244) | -0.0211 | (0.550) | 2.974 | (0.65) |
| **Vit A** | -1.478 | (0.308) | 0.957 | (0.827) | 943.928 | (0.11) |
| **Calcium** | -0.0657 | (0.209) | -0.155 | (0.175) | -20.492 | (0.24) |
| **Iron** | 0.00078 | (0.510) | -0.00201 | (0.251) | 0.324 | (0.26) |

Note: *DID estimates consider insignificant estimates as zeros.

**Table 15:** Difference-in-difference estimate (OLS) of positive circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| **Nutrients** | **Lab** | | **Unlab** | | **DID*** | **p-val** |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | 0.117 | (0.680) | -1.274 | (0.073) | -19.779 | (0.57) |
| **Total Fat** | 0.00497 | (0.577) | -0.0316 | (0.069) | -1.139 | (0.14) |
| **Cholesterol** | 0.110 | (0.190) | 0.125 | (0.355) | 1.907 | (0.80) |
| **Sodium** | 0.992 | (0.071) | -0.813 | (0.432) | -10.902 | (0.84) |
| **Carbohydrates** | -0.0233 | (0.352) | -0.0418 | (0.396) | 3.887 | (0.11) |
| **Protein** | 0.0262 | (0.014) | -0.0120 | (0.557) | -0.712 | (0.48) |
| **Sat Fat** | 0.00314 | (0.408) | -0.0114 | (0.069) | -0.656 | (0.03) |
| **Fiber** | -0.0012 | (0.791) | -0.00444 | (0.535) | 0.795 | (0.04) |
| **Sugars** | -0.0095 | (0.045) | 0.000991 | (0.879) | 0.049 | (0.90) |
| **Vit C** | -0.0578 | (0.248) | -0.0133 | (0.884) | 3.307 | (0.47) |
| **Vit A** | -4.137 | (0.385) | 11.10 | (0.339) | 890.764 | (0.05) |
| **Calcium** | -0.176 | (0.309) | -0.356 | (0.238) | -18.231 | (0.13) |
| **Iron** | 0.00341 | (0.383) | -0.00435 | (0.343) | 0.344 | (0.18) |

Note: *DID estimates consider insignificant estimates as zeros.

**Table 16:** Difference-in-difference estimate (TOBIT) of positive circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| **Nutrients** | **Lab** | | **Unlab** | | **DID*** | **p-val** |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | 0.117 | (0.679) | -1.682 | (0.062) | -21.790 | (0.56) |
| **Total Fat** | 0.00522 | (0.559) | -0.0403 | (0.075) | -1.105 | (0.25) |
| **Cholesterol** | 0.120 | (0.153) | 0.0837 | (0.642) | -1.159 | (0.89) |
| **Sodium** | 0.992 | (0.071) | -1.307 | (0.320) | -12.326 | (0.85) |
| **Carbohydrates** | -0.0233 | (0.351) | -0.0661 | (0.295) | 3.759 | (0.01) |
| **Protein** | 0.0263 | (0.014) | -0.0229 | (0.380) | -0.778 | (0.52) |
| **Sat Fat** | 0.00323 | (0.396) | -0.0150 | (0.063) | -0.652 | (0.10) |
| **Fiber** | -0.0009 | (0.817) | -0.0085 | (0.361) | 0.753 | (0.12) |
| **Sugars** | -0.0092 | (0.054) | -0.0013 | (0.883) | 0.034 | (0.93) |
| **Vit C** | -0.0511 | (0.310) | -0.0725 | (0.533) | 2.973 | (0.58) |
| **Vit A** | -3.744 | (0.433) | 4.520 | (0.755) | 945.651 | (0.17) |
| **Calcium** | -0.176 | (0.308) | -0.534 | (0.156) | -20.556 | (0.13) |
| **Iron** | 0.00341 | (0.382) | -0.0077 | (0.159) | 0.322 | (0.30) |

Note: *DID estimates consider insignificant estimates as zeros.

**Table 17:** Difference-in-difference estimate (OLS) of negative circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| **Nutrients** | **Lab** | | **Unlab** | | **DID*** | **p-val** |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | -13.40 | (0.507) | -5.608 | (0.912) | -19.583 | (0.53) |
| **Total Fat** | -0.528 | (0.407) | 2.816 | (0.024) | -1.116 | (0.18) |
| **Cholesterol** | -2.707 | (0.650) | 10.92 | (0.257) | 1.982 | (0.79) |
| **Sodium** | 0.639 | (0.987) | 152.1 | (0.040) | -9.848 | (0.84) |
| **Carbohydrates** | 2.072 | (0.247) | 1.632 | (0.643) | 3.888 | (0.06) |
| **Protein** | -0.623 | (0.414) | 3.202 | (0.029) | -0.686 | (0.43) |
| **Sat Fat** | -0.146 | (0.590) | 0.735 | (0.102) | -0.650 | (0.03) |
| **Fiber** | 0.0655 | (0.821) | 0.461 | (0.368) | 0.797 | (0.03) |
| **Sugars** | 0.161 | (0.636) | -0.853 | (0.068) | 0.042 | (0.92) |
| **Vit C** | 2.232 | (0.532) | 3.800 | (0.559) | 3.314 | (0.46) |
| **Vit A** | 206.8 | (0.543) | 361.2 | (0.664) | 890.171 | (0.04) |
| **Calcium** | 1.862 | (0.880) | 26.72 | (0.216) | -18.058 | (0.17) |
| **Iron** | 0.0907 | (0.745) | 0.623 | (0.058) | 0.348 | (0.17) |

Note: *DID estimates consider insignificant estimates as zeros.

**Table 18:** Difference-in-difference estimate (TOBIT) of negative circulation on nutrient intake per serving, those listed on the Nutrition Facts Panel.

| Nutrients | Lab | | Unlab | | DID* | p-val |
|---|---|---|---|---|---|---|
| | *Coeff* | *p-val* | *Coeff* | *p-val* | | |
| **Energy** | -13.40 | (0.506) | 13.04 | (0.845) | -21.365 | (0.64) |
| **Total Fat** | -0.529 | (0.407) | 4.630 | (0.017) | -1.080 | (0.33) |
| **Cholesterol** | -2.727 | (0.650) | 26.09 | (0.104) | -1.080 | (0.90) |
| **Sodium** | 0.639 | (0.987) | 206.2 | (0.044) | -11.295 | (0.84) |
| **Carbohydrates** | 2.072 | (0.246) | 2.883 | (0.535) | 3.769 | (0.25) |
| **Protein** | -0.623 | (0.414) | 4.274 | (0.036) | -0.753 | (0.56) |
| **Sat Fat** | -0.146 | (0.590) | 1.299 | (0.052) | -0.644 | (0.12) |
| **Fiber** | 0.0645 | (0.824) | 0.742 | (0.292) | 0.756 | (0.08) |
| **Sugars** | 0.156 | (0.647) | -0.628 | (0.344) | 0.030 | (0.94) |
| **Vit C** | 2.203 | (0.540) | 13.87 | (0.183) | 2.995 | (0.54) |
| **Vit A** | 205.4 | (0.547) | 1651.3 | (0.205) | 947.187 | (0.15) |
| **Calcium** | 1.862 | (0.880) | 40.43 | (0.163) | -20.345 | (0.20) |
| **Iron** | 0.0907 | (0.745) | 0.854 | (0.063) | 0.326 | (0.25) |

Note: *DID estimates consider insignificant estimates as zeros.

# CHAPTER 4: EXAMINING CHANGE IN CONSUMER HETEROGENEITY IN ADDED SUGARS CONSUMPTION WITH SPECIAL REFERENCE TO FAT AND CHOLESTEROL INTAKE

## Introduction

Added sugars or nutritive sweeteners have become an increasing share of the American diet. In 2004, added sugars provided, on average, 17 percent of their total calories (Hiza and Bente, 2007), an increase from 13.5 percent in 1990 (Popkin and Nielsen, 2003), which is higher than the recommended maximum of 10 percent[17]. Health researchers have linked its overconsumption to some of the major diseases and disorders in America, including obesity, diabetes, dyslipidemia, bone fractures, among other chronic diseases (Johnson and Fray, 2001; Drewnowski and Levine, 2003). High fat, high sugars with chronic stress also promote obdominal obesity (Kuo et al, 2008). Higher added sugar intake correlates with higher total calorie intake, and lower consumption of healthier alternatives such as fruits and vegetables (Lewis, et al., 1992; Bowman, 1999). Recent efforts by the scientific community and important associations, such as, the American Heart Association (AHA) to set an upper limit on added sugars intake makes this research very timely (Johnson et al, 2009). Furthermore, to improve diet, it is important to examine diet in accordance with the USDA dietary guidelines specified in the food guide pyramid. Therefore, a careful examination of the excess consumption of added sugars is imperative for better public health policies. The current availability of non-nutritive sugar substitutes also makes it interesting to study, since consumer’s have the option to substitute for added sugars, if the choice and necessary information is available.

A recent study found a negative relationship between levels of serum High Density Lipoprotein (HDL)[18] and proportion of energy obtained from added sugars (Welsh et al, 2010). Furthermore, high consumption of added sugars induce pancreas to release insulin to lower the excess sugar in the blood. High levels of insulin inhibit the release of certain growth hormones that suppress

[17] The recommendation is not to exceed 25% of total energy intake.

[18] HDL reduces risks of cardiovascular diseases by reducing cholesterol levels.

immune system (Adamkiewicz, 1963). Therefore, in this study, I focus on excess added sugar intake.

While estimating how education influences added sugars consumption is straightforward, it is a more important public health consideration is how education influences higher levels of added sugars consumption. Similarly, it would be more useful to know the relationship between fat and cholesterol intake, and added sugar intake at higher added sugar consumption levels. The NHANES dataset used in this study shows there is heterogeneity in added sugars consumption distribution. This could imply that those who adhere to the dietary guidelines are quite different from those who consume much higher than is recommended. Therefore, those who consume higher amounts warrant a closer study of their diet behavior.

American nutritional efforts, in the early 1980s, were geared towards reducing the dietary fat content especially due to its linkage to cardiovascular and other major diseases (Yen, 2005). Dietary advice had been to replace excess fats with carbohydrates, especially fiber-rich foods, such as, grains, vegetables, and fruits (Connor, 1990; WHO report, 2003). While the institutions focused on public education, the industry directed efforts to reduce fat percentage in food products, and the industry achieved this in certain products. To compensate for the taste, food manufacturers and restaurateurs substituted fat with higher added sugars and other ingredients (Kuchler et al, 2005). For example, the fat in Snackwell's low-fat cookies is replaced with high-caloric starches and sugars (Wansink and Chandon, 2006).

The substitution of fats by sugars was fostered by the reduction in cost per calorie of added sugars (Drewnowski and Levine, 2003). Consumers in general are more conscious of fat and fiber but less so about added sugars. Willett (1998) also suggested that American diet is replacing fats with added sugars.

Because of increased publicity against dietary fat, there is a concern that consumers might be consciously shifting away from high fat foods, such as, meats, to sugary foods, such as desserts, cakes, and pastries. But in consuming more sugary foods, they could be unknowingly consuming more fats as many solid sugar-rich foods also contain high amounts of fats (Emmett and Heaton, 1995). In addition, many sugary foods are cooked in hydrogenated oils which contain saturated fats, and trans fats, a more harmful form of fat than saturated fats (Hu, Manson, Willett, 2001).

Sugar and fat in combination show two interesting phenomenons. When combined, sweet and fat-rich food is more fatterning than "equicaloric amounts of sweet and fats consumed separately at different times in a day" (Drewnowski, 1990)[19]. Although sugars and fat and provide calories, they play very different and unique role in the making of a food product. Fat improves the texture of the food by increasing smoothness and palatability, whereas sugar increases sweetness. The combination of sugar and fat creates synergy by increasing the hedonic pleasure from such foods (Drewnowski, 1990; Drewnowski and Almiron-Roig, 2010). Besides being proven in the case of animals, an increased intake of sugars has also been noted in drug addicts under rehabilitation (Morabia et al, 1989). Subjects in a methodone maintenance program showed increased appetite for sugars and sweets (Zador, Wall and Webster, 1996). Sucrose, a type of sugar, causes neurochemical changes in brain sites that are associated with feeding and reward mechanisms.

Therefore, I try to find the association between healthy fat-based dietary choices and added sugars consumption. If fat-based dietary choices show no relationship then efforts could be made to address both issues individually. However, if added sugars are substituting for fat in the diet then both issues need to be addressed together. The association of added sugars with the percentage of saturated fat and levels of cholesterol in the diet is focused in this study as they are more related to cardiovascular diseases.

The rest of the paper is organized as follows. Section II discusses literature relevant to this study. A theoretical framework for econometric analysis using the household production model is presented in section III. The strategy to identify the linkage between dietary choices relating to fat and added sugars is described in section IV. Section V and VI describe the data and the econometric framework, respectively. The results and conclusions are presented in sections VII and VIII, respectively.

[19] In rats it was found to promote greater deposition of body fats.

## Review of Literature

Past health and nutrition research including economics has, in general, focused on fat intake to understand obesity trends (Willett, 2002; and Pirozzo, et al., 2003). But the obesity and overweight cases are increasing despite reduction in fat intake (Willett and Leibel, 2002). There is evidence that Americans are consuming lesser fat but more added sugars in the past three decades (Putnam and Gerrior, 1997; and Kennedy, Bowman and Powell, 1999). Lewis et al. (1992) showed an association of increased consumption of added sugars with an increase in total calories. In a review article on weight gain and sugar intake, Waxman (2004) showed evidence that added sugars did play a role in weight gain. Even though there are differences of opinion among scientists on the specific mechanism(s) of sugars affecting BMI, nutrition scientists share a consensus concerning the deleterious role of products particularly rich in added sugars in contributing to increased calorie intake (Bray, Nielson, and Popkin, 2004).

Given the negative health effects of excess calories, Variyam, Blaylock, and Smallwood (2002) developed a previous application of quantile regression method to examine consumer heterogeneity in saturated fat and cholesterol intake. They found wide differences in the consumption of macronutrients, namely, saturated fat, cholesterol and fiber, at different quantiles of the sample and observed statistically different coefficients for the same variable in different quantiles. For example, schooling years was found to have no effect in the 10th percentile cholesterol intake but had statistically significant estimates for the other quantiles.

## Health Demand Model

Household production models introduced by Becker (1965) and further developed by Grossman (1972), for studying health aspects of households, have been used in the health literature (Rosenzweig and Schultz, 1983; Kenkel, 1991; and Nayga, 2001). In this framework, household members are joint producers and consumers. They maximize their utility by consuming goods including health, H, and other goods, Xi, that are produced using time, human capital and purchased goods subject to technology and income constraints. If preferences are complete, reflexive, transitive, continuous and strongly monotonic, then there exists a utility function that represents these preferences (Varian, 1992).

The utility function of the household, satisfying the properties, can be written as,

(1) $$\boldsymbol{U} = \boldsymbol{U}\left(\boldsymbol{X}_i, \boldsymbol{H}\right), \qquad i = 1, \ldots\ldots, n,$$

and the production function of the health of household members by

(2) $$\boldsymbol{H} = \boldsymbol{H}\left(\boldsymbol{I}, \boldsymbol{D}_j, \boldsymbol{\mu}\right), \qquad j = 1, \ldots\ldots, m,$$

where I is the health input, Dj is a vector of individual characteristics, and μ represents the household specific health endowments that are known to the household but not controlled by them, for example, ethnicity. Health input includes activities that primarily increase the stock of health. Individual characteristics include human capital variables such as, education, income, health knowledge and health habits. Price differences based on urbanization, that is, city, suburbs and rural areas or across regions are captured by the respective set of dummy variables. The budget constraint, B, for the household for the n purchased goods, Xi, is

(3) $$\boldsymbol{B} = \sum_i \boldsymbol{X}_i \boldsymbol{P}_i$$

where the prices, P, and the income, B, are exogenous.

The household's reduced-form demand function for the purchased goods and foods, obtained by maximization of the utility function (eqn – (1)) subject to technology constraint (eqn – (2)) and income constraint (eqn – (3)), are

(4) $$\boldsymbol{X}_i = \boldsymbol{f}\left(\boldsymbol{F}, \boldsymbol{I}, \boldsymbol{D}_j, \boldsymbol{\mu}\right),$$

where, F for fat-based dietary choices.

**Measuring the link between fat consumption and added sugars**

In this study, I examine the covariate effects on added sugars, particularly at higher levels, which is of most concern from nutrition and health perspective. Fat and added sugar creates interesting synergy by increasing fat deposition in the body, and increasing the hedonic pleasure from food

(Drewnowski, 1990). But consumers can choose products of differeing amounts of sugar and fat. Even though added sugars, fat and cholesterol are consumed together in several products, they are available or could be combined in different proportions albeit to a limited extent. Using food consumption data, I examine if there is any relationship between added sugars, and fat- and cholesterol-based dietary choices. An index is introduced in the model which measures the healthfulness of the diet based on specific nutrients. Healthy Eating Index (HEI) is developed by the Center for Nutrition Policy and Promotion (CNPP), USDA, and is extensively used to study healthful dietary choices.

HEI has ten components. Each component received a score from one through ten based on the individual's diet adherence to the dietary guidelines in the food guide pyramid, published by the USDA. Three of which separately evaluate total fat, saturated fat, and cholesterol. Although total fats have specific recommendations, it is saturated fats and cholesterol that are considered far worse due to its adverse health effects, CVD in particular. Total fats and saturated fats are also very highly correlated which effects the estimates (Greene, 2008). Therefore, I include only saturated fats and cholesterol based dietary choices in this study. Each index point of the hei-saturated fat (HEI-sfat) indicates a 0.5 percentage point change in the respective component in the daily diet. In the case of hei-cholesterol (HEI-chol), each index point equals 15mg of cholesterol. These two HEI components are introduced as two variables measuring diet healthfulness for the respective components. The more an indvidual's diet adheres to the food guide pyramid recommendations, the higher the HEI values.

I expect the two HIE- variables to be non-linearly associated with added sugar, particularly because foods have varying amounts of added sugars, fat and cholesterol. Some foods contain high amounts of added sugars but are low in fat and cholesterol (carbonated drinks, for example); some foods are low in added sugars but high in fat and cholesterol (steak and pork chops, for example); and there are some foods that are low in both sugars, and fat and cholesterol (fruits and vegetables, for example). The relationship between calories from added sugars, and HEI-SFAT and HEI-CHOL looks more quadratic. HEI-CHOL seems a little cubic.

The two HEI variables used in this study was developed by the CNPP in 1995. In 2005, it was updated to reflect the then current guidelines. HEI-2005 has one component for saturated fat and cholesterol is included in the Solid Fat, Alcohol, and Added Sugar (SoFAAS) group. It, therefore, does not allow evaluation of both. Although HEI-2005 is a better measure to evaluate overall diet, HEI-original gives a better evaluation of the two components of interest in this study.

**Data Description**

In this study, I use the National Health and Nutrition Examination Survey (NHANES) conducted in 2005-06 by the National Center for Health Statistics (NCHS), part of the Centers for Disease Control and Prevention (CDC), in 2005-06. This survey was designed to collect information of the health and diet of Americans. It measures the different types of food and their respective amounts eaten, as well as their attitudes and knowledge about diet and health. The sample is selected based on geographic distribution and demographic characteristics of the population. The target population of NHANES was noninstitutionalized individuals 18 years and older from all the 50 states and Washington, DC. Eighteen years was the cut-off age since that is the age of majority in most states. Age of majority is when a person becomes a legal adults, gains full legal rights, and assumes full liability of own actions. The interviewed sample unweighted response rate was 80.45 percent, and thus considered a good representation of the population.

The NHANES contains information on serving sizes of the different food categories and calories. The mean and median consumption was about 470 and 412 calories (Tables 19 and 20). The mean and median score of HEI-SFAT was 6.3 and 7.8, and those of HEI-CHOL were 6.9 and 10. Respondents received the highest attainable score of 10, indicating full adherence to respective nutrient(s) dietary guidelines, at the 43rd percentile in case of HEI-CHOL and at 59th percentile in case of HEI-SFAT[20].

[20] Figures not shown in the Tables.

Food intake of each individual was recorded through two dietary interviews 3-10 days apart. Both dietary food recall interviews were conducted by dietary interviewers. Dietary recall interview in the first day is conducted in a Mobile Examination Center (MEC), which contains measuring guides to help respondents report volume and dimensions of the food items. These measuring guides are designed to estimate portion sizes. The second dietary recall interview, after 3-10 days, was over the phone. Trained interviewers were employed to collect information for all dietary interviews.

In this study, I use average of the two days for each individual as individual observations. Table 19 also shows the mean of all variables, which account for various factors that could influence caloric needs or be associated with differential added sugars consumption.

**Econometric Framework**

I use the quantile regression method which allows estimation at different points in the distribution and allows the covariate effects to vary, which is particularly useful in the presence of heterogenous variances in the mean of the response variable in the probability distribution. Understanding the nature of consumer heterogeneity across the quantiles of conditional distribution of added sugars may assist policy makers in designing effective food and health policies to address the growing epidemic of diseases with direct or indirect linkages with over-consumption of added sugars. Foods rich in added sugars could be fat-free (sodas, for example), fat-rich (cheesecake, for example). There are also fat-rich foods that contain low or no added sugars (meat balls, for example). Thus one cannot expect a linear relationship between fats and added sugars. Such heterogenous covariate effects could be modeled in quantile regression.

In order to measure the nature of heterogeneity in the consumption of added sugar given a set of covariates, a quantile regression is applied to estimate models for the conditional quantile (or percentile or fractile) functions. Further, the distribution of the added sugars consumption is slightly right-tailed which indicates that mean regression will yield biased estimates (Fig 2). The advantage of quantile regression over the linear regression methods, which minimizes the sum of squared residuals, is that the quantile regression provides for a more complete statistical analysis of the stochastic relationship among random variables by estimating the entire conditional output distribution (Koenker and Hallock, 2001). OLS limits comparison to mean intakes but the quantile regression allows us to characterize the heterogeneous effects of a set of covariates at different quantiles of consumption.

Quantile regression allows the parameters to vary across specified quantiles while the estimates in the linear quantile regression model have the same interpretation as those in any other linear model. Deaton (1997) also shows how quantile regression characterizes the conditional distribution in the presence of heteroskedasticity. Additional features of quantile regression are that: the objective function is a weighted sum of absolute deviations which makes the estimators insensitive to outliers on the dependent variable thus making it a robust measure of location; and its estimators are more efficient than OLS when the error terms are non-normal (Buchinsky, 1998).

A convenient but important aspect of quantile regression is that the distribution of the error term, ui, is not specified and the error term is assumed to satisfy the exogeneity restriction in each, i.e., expectation of error term conditional on regressors is zero. If the true model isIn this section, I provide neuroscientific evidence of dual-self in an individual. Using functional $y_i = x_i^{'}\beta_\theta + u_{\theta i}$, then $Quant_\theta\left(y_i \middle| x_i\right) = x_i^{'}\beta_\theta$ denotes the conditional quantile of $y_i$, calories from added sugars, conditional on the regressor vector $x_i$.

The estimator for $\beta_\theta$ of the θ$^{th}$ quantile is obtained by solving

$$\min_\beta \frac{1}{n}\left\{ \sum_{i:y_i \geq x_i^{'}\beta} \theta \mid y_i - x_i^{'}\beta \mid + \sum_{i:y_i < x_i^{'}\beta} (1-\theta) \mid y_i - x_i^{'}\beta \mid \right\}$$

This framework allows the marginal effects of the covariates, given by $\beta_\theta$, to vary across quantiles.

**Results**

Studies on dietary outcomes use both aggregate daily calories and energy density. Aggregate calories are useful to know the total amount of calories from sugars, but it does not control for total food intake. Energy density, in this study, is measured by calories from added sugars per 100 gram of food. As the definition states, it indicates how energy dense an individual's diet is. Dietary guidelines emphasize bulky foods, such as, whole grains, vegetables, and fruits, which are generally of lower density. High-density foods have more sugars, fats, or both. In the distribution, sugar density increases to the right, but may not necessarily be high in total calories. The correlation between the two units is only 0.25.

Following the literature on quantile regression, I present estimates at the 10th, 25th, 50th, 75th, and 90th percentile along with the OLS estimates at the mean level. Table 21 and 22 presents results from the OLS and the quantile regression model.

*Fat and Cholesterol Based Dietary Choices*

Each percentage point increase in HEI-sfat was associated with an increase in about 20 calories from added sugars. In terms of one percentage point increase in saturated fat, in the range 10 - 15 percent, this implied an increase of about 10 calories. Significance of these variables clearly shows that consumer's diet differs on healthfulness when choosing between fat content and cholesterol, and added sugars. Respondents consumed more added sugars with improvement in saturated fat.

The quantile regression estimates show that there is not much difference in the substitution of added sugars intake. The relationship, however, weakens at the upper tail, indicating a wider variation (or larger covariance) of HEI-SFAT at very high levels of sugars. In fact, the HEI-SFAT variables are not significant at quantiles above 0.90, which are not reported here. The quadratic component is not significant at the median intake and above, thus indicating a more linear relationship at levels of intake that are of interest from the health perspective.

In contrast to the association observed with saturated fat, added sugars showed no relationship with changes in cholesterol levels. The linear component was not significant in either the OLS or the quantile regression. The quadratic component, however, did show a weak relationship, particularly that a unit increase in the HEI-CHOL score was associated with only a calorie decrease in added sugars. Quantile regression results show that this was observed about the 75th quantile. Since the range of the HEI-CHOL was 300 to 450 mg, and considering the fact that there are 25 and 35 mg of cholesterol in each serving of doughnut and whole milk, one or two calories do not pose any serious issue.

Among the estimates of all the variables, the saturated fat variable shows a sizeable contribution to the calories obtained from added sugars. To illustrate this, let us consider the label users who consume 46 calories less than label non-users. The values of HEI-sfat are in the range of 0 through 10. Therefore, the magnitude indicates an increase of up to 110 calories (product of the OLS-coefficient and the mean of HEI-SFAT) of added sugars in response to changes in saturated fat in the diet.

Each of the HEI components is bound at both the lower and upper end. In particular, percentage of saturated fat in the diet below 10 percent received a score of 10 while above 15 percent received a nil (or zero) score. This would bias the estimates upward, which imply a lower magnitude of the true value.

The sugar density revealed a similar but slightly different relationship with saturated fat and cholesterol (Table 21). The OLS estimate showed an increasing intake of sugars at a decreasing rate. It is interesting to note that this relationship is significant only at the median and lower quantiles and not at upper levels. As the food becomes more sugar dense, there appears to be more variation in the saturated fat content. Perhaps, at higher levels, respondents could be consuming a variety of foods with varying amounts of added sugar and saturated fat, such as sweetened beverages that are very low in fats, desserts rich in fat and sugar, salty snacks low in sugars, among others.

Cholesterol showed no significant relationship with sugars.

*Nutrition Label Use*

Nutrition labels are a useful tool to make healthier choices and those who used labels consumed considerably lower amounts of sugars by about 45 calories. At upper levels of intake (0.75q and higher), however, they were consuming at least 50 calories less than those who did not use labels. The magnitude was higher, about 55 calories, at the upper tail compared to about 20 calories at the lower tail. In the energy density model, label users showed lower intake of sugars only at the median and lower quantiles except for a very weak relationship at the upper tail.

## Conclusions

This study focuses on the consumption of added sugars, which is steadily increasing in absolute levels and in the share of the total food intake. Since consumption of added sugars is a concern only if its contribution is higher than 10 percent of daily caloric intake, a quantile regression method was applied to give a more complete picture of the effects of the covariates. Significance of the variables on saturated fat suggest a strong relationship between choices based on added sugars and saturated fat. The OLS results indicate that consumers who are making healthier choices in terms of saturated fat are consuming more added sugars but those making healthier choices in terms of cholesterol show no systematic relationship with added sugars. An increase in added sugars in response to improvements in diet based on saturated fats showed a negative relationship from a health perspective.

The quantile regression model adds to the analysis by showing that the association between added sugars and saturated fat-based dietary choices weakens at very high levels of sugars intake. Furthermore, the relationship becomes more linear as seen by the insignificance of the quadratic component. In terms of sugar density, there is no systematic statistical relationship between added sugars and saturated fat at higher levels of sugar density. This broader picture helped us understand the effects of covariates in explaining differences in the consumption of added sugars. For example, association of sugar dense foods with saturated fats show up in OLS, but quantile regression shows no significant relationship at higher levels. Other variables also showed different estimates at different quantiles of the added consumption distribution in contrast to the OLS estimate. Therefore, an analysis involving the OLS method alone could be misleading, especially when analyzing nutrients that are of concern only at higher levels.

One possible reason for the negative relationship between added sugars and saturated fats could be substitution of the ingredients at the industry level and the other could be at the consumers' level. A lot of focus on fat could have caused this substitution at both industry and consumer level. At the consumer level this could indicate that those who are limiting saturated fats are in fact consuming more added sugars. This finding is of concern to the policy makers. This dataset, however, does not allow us to determine which could be causing a bigger substitution by the industry of the consumers. In the case of cholesterol, however, it seems plausible that cutting down of cholesterol by the industry is producing such healthy behaviors.

Among other variables, there is heterogeneity in dietary choice across label use, education, income, and other demographic variables in the conditional consumption distribution of added sugars. In the energy density model, label users consumed more sugar dense foods. This relationship, however, is only observed at the median and lower quantiles. Even though it is good not to observe positive intake or more dense foods, the fact that it is not negative is a concern.

The reason for change in consumption of different food categories needs to be explored further using prices and other important variables. For instance, taste could be one criterion for one group while another group might be substituting foods rich in added sugars for fatty foods in their diet (Bray, Nielson, and Popkin, 2004).

The findings on the relationship between added sugars and dietary choices based on saturated fat and cholesterol favor the efforts of the Center for Science in the Public Interest (CSPI) to persuade FDA to regulate nutrient label claims on one nutrient (e.g. saturated fats) when a particular food product has high levels of some other nutrient (e.g. added sugars). Such labeling regulations are imperative particularly because focus on one macronutrient could shift consumer preferences to others and thereby maintaining similar caloric intake which might have little or no impact on addressing overweight, obesity and related health problems. Food companies very often use nutrition marketing of foods that are high in added sugars and/or fats, whereby only few of the positive nutritional aspects of the product are advertized or projected (Colby et al, 2010).

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**Figure 1**: Kernel density estimation of the added sugars intake (calories) in the sample.

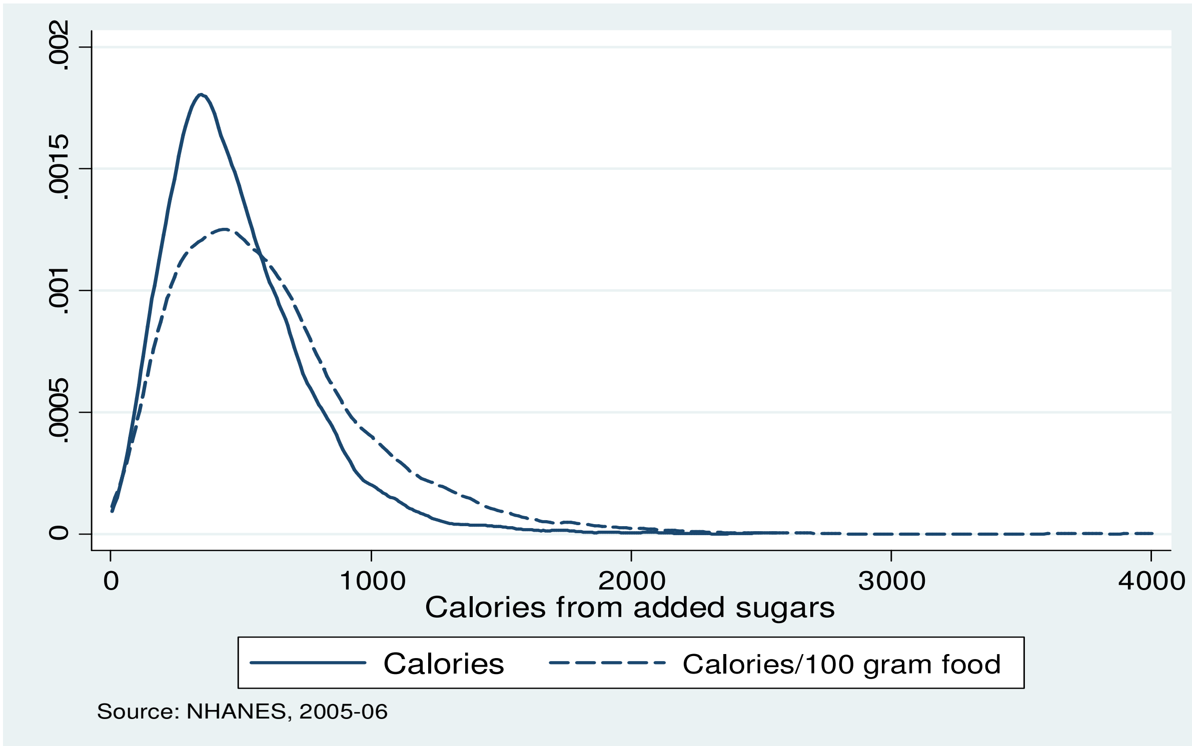


**Figure 2**: Calories from added sugars at select points in the distribution in 2005-06.

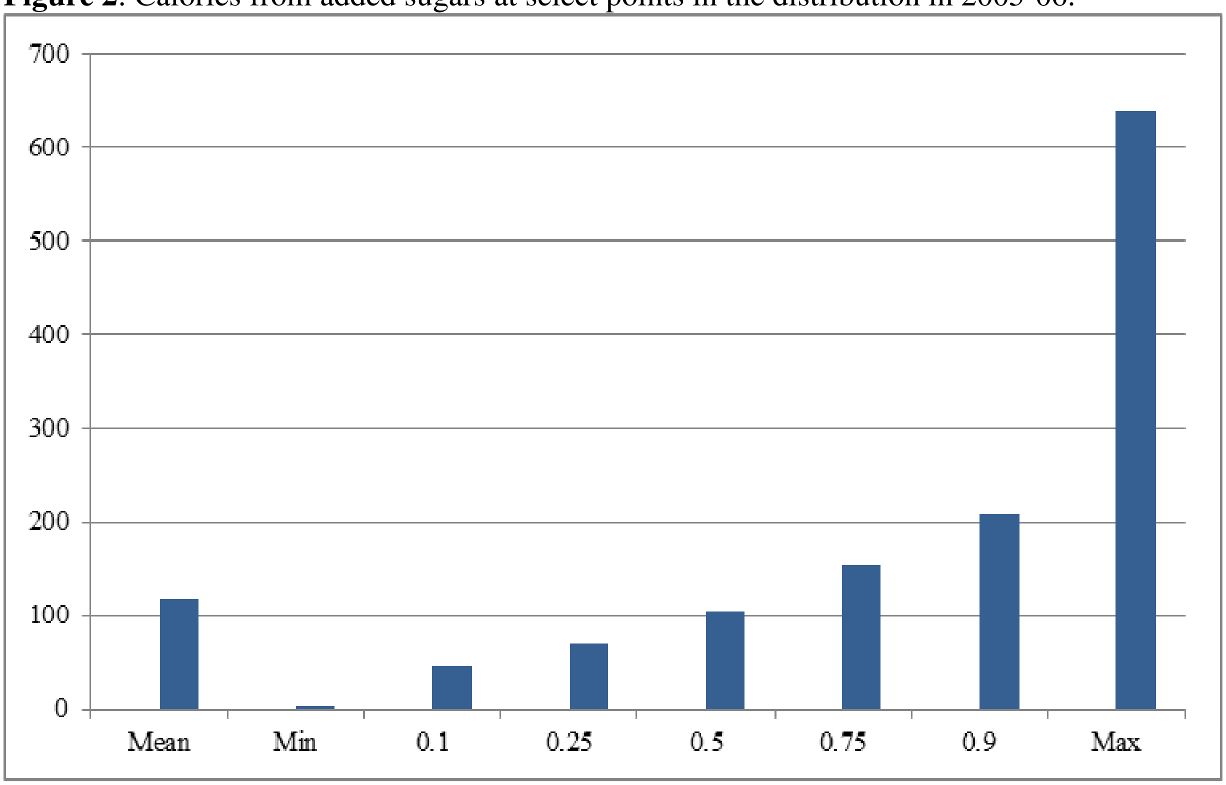

**Table 19**: Weighted sample means (or percent) of the explanatory variables used in the econometric model.

| **Variables defined** | **Mean** | ***SD*** |
|---|---|---|
| Added Sugar | 470 | *278* |
| HEI* for total fat | 6.4 | *3.7* |
| HEI saturated fat | 6.3 | *4.0* |
| HEI cholesterol | 6.9 | *4.3* |
| Label Use (use of label for any info=1, else=0) | 40 | - |
| Education | | |
| Less than High School (LHS) | 18 | - |
| High School | 25 | - |
| Some College | 31 | - |
| College Graduate | 26 | - |
| Income ($)† | 44,161 | *25,906* |
| Age (years) | 47 | *17* |
| Gender (female=1, male=0) | 52 | - |
| Ethnicity | | |
| Mexican american (yes=1, else 0) | 8 | - |
| Other hispanic (yes=1, else 0) | 3 | - |
| White non-hispanic (yes=1, else 0) | 72 | - |
| Black non-hispanic (yes=1, else 0) | 11 | - |
| Other (yes=1, else 0) | 5 | - |
| Height | 168.9 | *10.1* |
| Household size | 2.9 | *1.51* |
| Diabetic (diabetic=1, else 0) | 8 | - |
| Body Mass Index (BMI) | 28.77 | *6.75* |

Data source: NHANES 2005-06
*HEI stands for Healthy Eating Index.
† Income in 2005-06 is deflated with Consumer Price Index developed by the Bureau of Labor Statistics to reflect equivalent income in 1995. Nominal income in 2005-06 was $56,592 with SD of $33,198.

**Table 20**: Calories and percent of total calories from added sugars.

| Percentile | Calories | Percent |
|---|---|---|
| min | 5 | 3 |
| p10 | 179 | 15 |
| p25 | 278 | 18 |
| p50 | 412 | 21 |
| *mean* | *470* | *22* |
| p75 | 608 | 23 |
| p90 | 827 | 25 |
| max | 2,558 | 31 |

**Table 21**: OLS and Quantile regression estimates of added sugars consumption model. (unit is total calories from sugars).

| Variables | OLS | Quantile Regression Estimates | | | | |
|---|---|---|---|---|---|---|
| | | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| *HEI-indices* | | | | | | |
| HEI-saturated Fat | 17.42* | 16.43* | 18.49* | 18.99* | 16.33* | 18.95‡ |
| | (0.000) | (0.002) | (0.000) | (0.000) | (0.002) | (0.057) |
| HEI-sfat square | -0.522 | -1.138† | -1.118* | -0.950† | -0.297 | -0.145 |
| | (0.196) | (0.016) | (0.003) | (0.022) | (0.523) | (0.870) |
| HEI-cholesterol | -1.524 | -2.828 | 0.126 | -2.075 | -0.0780 | 6.739 |
| | (0.780) | (0.653) | (0.980) | (0.711) | (0.990) | (0.587) |
| HEI-chol square | -1.017† | -0.321 | -0.739 | -0.912‡ | -1.431† | -2.248‡ |
| | (0.049) | (0.589) | (0.118) | (0.085) | (0.017) | (0.055) |
| Label use | -46.26* | -20.92† | -33.47* | -33.20* | -51.58* | -56.57* |
| | (0.000) | (0.029) | (0.000) | (0.000) | (0.000) | (0.002) |
| *Education (Less than high school omitted)* | | | | | | |
| High school grad | 16.83 | 1.063 | 14.07 | 27.87† | 31.73† | 25.45 |
| | (0.123) | (0.935) | (0.164) | (0.013) | (0.011) | (0.292) |
| Some college | 14.95 | -3.030 | 19.69† | 21.23‡ | 33.50* | 33.16 |
| | (0.169) | (0.806) | (0.048) | (0.058) | (0.008) | (0.168) |
| College grad | -7.723 | 12.68 | 26.31† | 20.37 | 0.540 | -22.05 |
| | (0.555) | (0.410) | (0.031) | (0.130) | (0.972) | (0.457) |
| Income (in $1,000) | -3546.5† | 2691.4 | 1144.9 | -3668.7† | -4718.7* | -9085.7* |
| | (0.013) | (0.121) | (0.395) | (0.013) | (0.006) | (0.007) |
| Income square | 38876.5* | -22870.6 | -7313.9 | 37679.7† | 50454.3* | 98900.0* |
| | (0.008) | (0.187) | (0.593) | (0.013) | (0.003) | (0.003) |

Table 21 contd…

| Variables | OLS | Quantile Regression Estimates | | | | |
|---|---|---|---|---|---|---|
| | | **0.10** | **0.25** | **0.50** | **0.75** | **0.90** |
| *Ethnicity (White non-hispanic omitted)* | | | | | | |
| Mexican American | -31.63* | 4.777 | 16.52 | -9.221 | -36.28* | -55.29† |
| | (0.007) | (0.736) | (0.130) | (0.442) | (0.008) | (0.041) |
| Other Hispanics | -44.78† | -47.79‡ | -20.15 | -20.15 | -60.67† | -34.17 |
| | (0.046) | (0.070) | (0.330) | (0.382) | (0.020) | (0.497) |
| African American | -9.402 | 9.257 | 17.19‡ | 8.923 | -15.97 | -33.25 |
| | (0.329) | (0.415) | (0.053) | (0.369) | (0.155) | (0.133) |
| Other races | -62.96* | -37.37‡ | -50.82* | -58.37* | -73.95* | -59.39 |
| | (0.001) | (0.089) | (0.003) | (0.003) | (0.001) | (0.167) |
| Age | -4.725* | -3.802* | -5.972* | -5.650* | -6.143* | -7.082* |
| | (0.000) | (0.003) | (0.000) | (0.000) | (0.000) | (0.005) |
| Age square | 0.0227† | 0.0324† | 0.0481* | 0.0356* | 0.0323† | 0.0347 |
| | (0.046) | (0.012) | (0.000) | (0.002) | (0.015) | (0.181) |
| Gender | -35.13* | -11.51 | -16.42 | -42.29* | -53.88* | -52.42† |
| | (0.001) | (0.378) | (0.104) | (0.000) | (0.000) | (0.030) |
| Height | 3.906* | 1.341† | 2.089* | 3.080* | 4.239* | 7.202* |
| | (0.000) | (0.039) | (0.000) | (0.000) | (0.000) | (0.000) |
| Household size | -1.548 | 2.025 | -0.481 | -1.147 | -6.105‡ | -1.214 |
| | (0.566) | (0.520) | (0.847) | (0.679) | (0.052) | (0.844) |
| Diabetic | -125.0* | -70.39* | -96.49* | -103.0* | -149.6* | -177.4* |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| Constant | 67.61 | 68.87 | 117.3 | 171.7 | 229.7‡ | -55.26 |
| | (0.513) | (0.566) | (0.219) | (0.107) | (0.055) | (0.812) |
| Observations | 4756 | 4756 | 4756 | 4756 | 4756 | 4756 |
| R-squared | 0.175 | | | | | |

Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%

**Table 22**: Quantile regression estimates of added sugars consumption model (unit is grams per 1,000 total calories).

| Variables | OLS | Quantile Regression Estimates | | | | |
|---|---|---|---|---|---|---|
| | | **0.10** | **0.25** | **0.50** | **0.75** | **0.90** |
| *HEI-indices* | | | | | | |
| HEI-saturated Fat | 19.93* | 24.41* | 29.12* | 21.99* | 11.63 | 8.711 |
| | (0.002) | (0.000) | (0.000) | (0.002) | (0.217) | (0.526) |
| HEI-sfat square | -2.006* | -2.164* | -2.796* | -2.062* | -1.276 | -1.162 |
| | (0.000) | (0.000) | (0.000) | (0.001) | (0.125) | (0.336) |
| HEI-cholesterol | 0.0686 | 0.495 | 3.146 | 2.329 | 16.16 | 22.31 |
| | (0.993) | (0.940) | (0.658) | (0.779) | (0.155) | (0.173) |
| HEI-chol square | -0.539 | -0.421 | -0.768 | -0.769 | -2.252† | -2.665‡ |
| | (0.461) | (0.500) | (0.254) | (0.327) | (0.036) | (0.084) |
| Label use | 26.37† | 24.13† | 24.57† | 29.78† | 13.61 | 47.41‡ |
| | (0.021) | (0.014) | (0.020) | (0.016) | (0.413) | (0.050) |
| *Education (Less than high school omitted)* | | | | | | |
| High school grad | -4.638 | 10.64 | -5.111 | 6.747 | 14.85 | -8.303 |
| | (0.764) | (0.437) | (0.722) | (0.678) | (0.510) | (0.801) |
| Some college | 37.28† | 29.25† | 36.98* | 45.54* | 56.16† | 34.90 |
| | (0.016) | (0.030) | (0.009) | (0.005) | (0.012) | (0.290) |
| College grad | 80.97* | 81.65* | 80.41* | 96.79* | 111.6* | 105.2* |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.009) |
| Income (in $1,000) | 3974.7‡ | 4799.6* | 4480.0† | 4560.4† | 5411.7‡ | 4143.6 |
| | (0.051) | (0.006) | (0.018) | (0.036) | (0.062) | (0.356) |
| Income square | -32879.7 | -43516.5† | -39381.4† | -40618.3‡ | -47133.8 | -31749.8 |
| | (0.115) | (0.013) | (0.039) | (0.069) | (0.118) | (0.492) |

Table 22 contd…

| Variables | OLS | Quantile Regression Estimates | | | | |
|---|---|---|---|---|---|---|
| | | 0.10 | 0.25 | 0.50 | 0.75 | 0.90 |
| *Ethnicity (White non-hispanic omitted)* | | | | | | |
| Mexican American | 11.68 | 7.994 | 32.14† | 24.95 | 18.51 | 11.95 |
| | (0.480) | (0.568) | (0.037) | (0.157) | (0.443) | (0.736) |
| Other Hispanics | 48.65 | 9.857 | 24.14 | 12.72 | 9.381 | 266.1* |
| | (0.126) | (0.718) | (0.413) | (0.708) | (0.838) | (0.000) |
| African American | -33.73† | -18.05 | -24.02‡ | -23.51 | -34.40‡ | -39.65 |
| | (0.014) | (0.112) | (0.057) | (0.108) | (0.086) | (0.171) |
| Other races | -88.49* | -71.70* | -68.50* | -89.88* | -84.67† | -65.57 |
| | (0.001) | (0.002) | (0.006) | (0.002) | (0.031) | (0.240) |
| Age | 7.727* | -0.996 | 1.607 | 4.754* | 10.64* | 17.74* |
| | (0.000) | (0.465) | (0.270) | (0.000) | (0.000) | (0.000) |
| Age square | -0.0213 | 0.0368* | 0.0232 | | -0.0415‡ | -0.0812† |
| | (0.185) | (0.007) | (0.119) | | (0.079) | (0.024) |
| Gender | 50.59* | 47.07* | 53.17* | 57.17* | 44.30‡ | 57.00‡ |
| | (0.001) | (0.000) | (0.000) | (0.001) | (0.051) | (0.083) |
| Height | 1.102 | 0.620 | 0.197 | 1.261 | 0.448 | 1.647 |
| | (0.166) | (0.341) | (0.790) | (0.140) | (0.696) | (0.330) |
| Household size | -1.211 | 1.753 | -3.248 | 2.820 | -8.291 | -8.547 |
| | (0.751) | (0.584) | (0.361) | (0.490) | (0.133) | (0.290) |
| Diabetic | -102.6* | -51.32* | -81.83* | -93.54* | -147.0* | -206.0* |
| | (0.000) | (0.002) | (0.000) | (0.000) | (0.000) | (0.000) |
| Constant | 85.15 | -14.74 | 123.0 | 29.74 | 328.2 | 165.7 |
| | (0.561) | (0.902) | (0.371) | (0.850) | (0.119) | (0.587) |
| Observations | 4756 | 4756 | 4756 | 4756 | 4756 | 4756 |
| R-squared | 0.107 | | | | | |

Standard errors in parentheses; ‡ significant at 10%; † significant at 5%; * significant at 1%

# CHAPTER 5: SUMMARY

This dissertation research finds that behavioral factors and and nutrition information media campaign do influence dietary choices. The first essay found that calorie intake due to impulsiveness outweighs calorie reduction by self-control, which has not been emphasized in previous non-experimental economic research. This provides evidence of the influence of obesogenic environment, which according to CDC promotes increased food intake and unhealthful foods, on food consumption. Another important result was that those consuming higher calories were, although, more impulsive exercised more self-control.

The second essay found limited effects of nutritional information campaign on dietary outcomes. Using media content analysis in a difference-in-difference framework, the second essay found limited effects of the media information campaign of NLEA on dietary outcomes.

An important result from the third essay was that those who made healthier choices with respect to saturated fat did not make healthier choices in terms of added sugars. This is suggestive of the fact that focusing on one macronutrient (like reducing fat in the diet) could shift consumer preferences to others, and thereby maintaining similar caloric intake which would have little or no impact on addressing overweight, obesity, and other health problems. These findings favor the efforts to regulate nutrient label claims on one nutrient (e.g. saturated fats) when a particular food product has high levels of some other nutrient (e.g. added sugars).

This dissertation research showed important behavioral and policy influences on nutrition choices.

# CHAPTER 6: APPENDIX

Sample questions from the NDNS survey is given below to describe how the self-control measures were created.

Worried: Do you get the desire to eat when you are anxious, worried or tense?
1. Never
2. Seldom
3. Sometimes
4. Often
5. Very Often

Lonely: Do you have a desire to eat when you are feeling lonely?
1. Never
2. Seldom
3. Sometimes
4. Often
5. Very Often

The above two questions fall under emotional self-control category where lower ordinal scores related to stronger self-control and higher ordinal scores indicate lower self-control. Thus an individual who chose option 1 for first question and 2 for the second one will have an emotional self-control score of 3. This individual with 3 score will be considered high in self-control relative to another who has scores above 3.

**List of questions**

*Restrained Eating*

1. If you have put on weight, do you eat less than you usually do?
2. Do you try to eat less at mealtimes than you would like to eat?
3. How often do you refuse food or drink offered because you are concerned about your weight?
4. Do you watch exactly what you eat?
5. Do you deliberately eat foods that are slimming?
6. When you have eaten too much, do you eat less than usual the following days?'
7. Do you deliberately eat less in order not to become heavier?
8. How often do you try not to eat between meals because you are watching your weight?
9. How often in the evening do you try not to eat because you are watching your weight?
10. Do you take into account your weight with what you eat?

*Emotional Eating*

11. Do you have the desire to eat when you are irritated?
12. Do you have a desire to eat when you have nothing to do?
13. Do you have a desire to eat when you are depressed or discouraged?
14. Do you have a desire to eat when you are feeling lonely?

15. Do you have a desire to eat when somebody lets you down?
16. Do you have a desire to eat when you are cross?
17. Do you have a desire to eat when you are approaching something unpleasant to happen?
18. Do you get the desire to eat when you are anxious, worried or tense?
19. Do you have a desire to eat when things are going against you or when things have gone wrong?
20. Do you have a desire to eat when you are frightened?
21. Do you have a desire to eat when you are disappointed?
22. Do you have a desire to eat when you are emotionally upset?
23. Do you have a desire to eat when you are bored or restless?

*External Eating*

24. If food tastes good to you, do you eat more than usual?
25. If food smells and looks good, do you eat more than usual?
26. If you see or smell something delicious, do you have a desire to eat it?
27. If you have something delicious to eat, do you eat it straight away?
28. If you walk past the baker do you have the desire to buy something delicious?
29. If you walk past a snackbar or a cafe, do you have the desire to buy something delicious?
30. If you see others eating, do you also have the desire to eat?
31. Can you resist eating delicious foods?
32. Do you eat more than usual, when you see others eating?
33. When preparing a meal are you inclined to eat something?

**Figure 3**: Individual standard deviations of the seven-day calorie intake plotted against the average daily calories.