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Ascertaining the Impact of the 2000 USDA Dietary Guidelines for Americans on the Intake of Calories, Caffeine, Calcium, and Vitamin C from At-Home Consumption of Nonalcoholic Beverages

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Obesity is one of the most pressing and widely emphasized health problems in America today. Beverage choices made by households have impacts on determining the intake of calories, calcium, caffeine, and vitamin C. Using data from the Nielsen Homescan Panel over the period 1998–2003, and a two-way random-effects Fuller-Battese error components procedure, we estimate econometric models to examine economic and demographic factors affecting per-capita daily intake of calories, calcium, caffeine, and vitamin C derived from the consumption of nonalcoholic beverages. Our study demonstrates the effectiveness of the USDA 2000 Dietary Guidelines in reducing caloric and nutrient intake associated with nonalcoholic beverages.

Key Words: Nielsen Homescan Panel, nonalcoholic beverages, nutrient and caloric intake, USDA Dietary Guidelines

JEL Classifications: D10, D12, I10, I18

Obesity among all walks of life is one of the most pressing and widely emphasized nutrition-related health problems in America today. According to the publication, "A Handbook on Obesity in America," by the Endocrine Society and the Hormone Foundation (A Handbook on Obesity in America, 2005), 127 million adults in the United States are overweight (body mass index [BMI][1] 25–29.9 kg/m^2), 60 million are obese (BMI 30–39.9 kg/m^2), and 9 million are extremely obese (BMI 40 kg/m^2 or greater than 40 kg/m^2). Nayga (2008) reported that recent obesity rates for men and women in the United States are 36.5% and 41.8%, respectively.

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[1] BMI refers to body mass index, calculated as a ratio between a person's height (in meters) and weight (in kilograms) and is expressed as follows: BMI = weight(kilograms)/height(meters)^2 or BMI = (weight [pounds]*703)/height [inches]^2.

The overweight/obesity problem is not only an issue with adults, but also with children and adolescents. The Centers for Disease Control and Prevention (2007) of the U.S. Department of Health and Human Services reports that from 1980 through 2004, the prevalence of the overweight issue is increasing among children and adolescents in America. The percentage of children aged 2–5 years classified as overweight increased from 5% to 13.9% from 1980 to 2004, and the percentage of children aged 6–11 years classified as overweight rose from 6.5% to 18.8%. The percentage of adolescents (12–19 years) classified as overweight also increased from 5% to 17.4% over this time period.

In addition to environmental and genetic factors, the selection of food and beverages is a contributing factor to the condition of obesity. With the publication of the 2000 and 2005 USDA Dietary Guidelines for Americans, the role of beverages in the American diet increased in attention. There is a very wide variation in beverages in terms of their energy (caloric) content and nutrient composition, ranging from zero-calorie bottled water to low-calorie diet soft drinks to heavily caloric coffee drinks. Therefore, excessive consumption of beverages is not necessarily a good dietary choice as a result of extra calories they can contribute toward the daily recommended calorie requirement designed through a Food Guidance System (MyPyramid) published by the USDA. As indicated in the 2005 Dietary Guidelines for Americans, daily calorie requirements differ for individuals based on age, gender, and physical activity level (it could be as low as 1,400 kcal for children to as high as 3,000 kcal for an active male). However, the 2,000-calorie level is used as a reference level to be consistent with the Nutrition Facts Panel printed on food and beverage labels. Therefore, beverage choices made by individuals may have a potentially important influence on the quality of the diet and, more importantly, on the risk of being obese and overweight.

The 2000 Dietary Guidelines gave prominence to the role of soft drinks and other sweetened beverages on the U.S. obesity problem. The 2005 Dietary Guidelines reiterated the need to limit calories from soft drinks, emphasizing even more strongly the need to increase consumption of nonfat and/or low-fat milk in lieu of carbonated soft drinks (Dietary Guidelines for Americans, 2000 and 2005).

Consumption of nonalcoholic beverages also contributes various kinds of nutrients to the diet. Milk is a major source of calcium and vitamin D. According to the U.S. Department of Health and Human Services (2000), calcium and vitamin D are two nutrients that are of public concern. In an analysis of USDA food consumption survey data, Yen and Lin (2002) found that for each 1-ounce reduction in milk consumption by a child, calcium intake was reduced by 34 mg. Juices are prepared from either fruits or vegetables and are good sources of vitamin C. Also, there are calcium-fortified fruit juices available today such as orange juice. Vitamin C and calcium are two of the healthy nutrients that come from consumption of nonalcoholic beverages. Caffeine is another ingredient found in most carbonated soft drinks, coffee, and tea. According to the American Beverage Association (2007), beverage manufacturers have responded positively to the changing needs and interests of consumers by introducing many low-calorie, zero-calorie, calcium-fortified, nutrient-enhanced, and decaffeinated beverage choices.

Many U.S government programs targeting nutritional enhancement of households such as the Supplemental Nutrition Assistance Program (SNAP or formally the Food Stamp Program), National School Lunch Program, School Breakfast Program, and Special Supplemental Food Program for Women, Infants and Children (WIC) are in need of more current information pertaining to nonalcoholic beverage consumption. Profiling of households is important to identify demographic populations potentially at risk in the consumption of nonalcoholic beverages. For example, the WIC program provides vitamin C and calcium-rich beverages such as fruit/vegetable juices and milk to its recipients. Eligibility for such programs is evaluated through a multitude of factors, including a poverty threshold (calculated taking into account annual income of the household and household size). Government food assistance programs center attention on 100%, 130%, or 185% of the poverty thresholds.

Objectives

After the publication of the aforementioned Dietary Guidelines, it is hypothesized that consumers are well informed about the nutritional contribution of beverages to their diet. As a result, their consumption patterns of nonalcoholic beverages should change. That is to say, one question of interest is whether or not the 2000 and 2005 USDA Dietary Guidelines for Americans have been effective in making changes in the intake of calories, calcium, caffeine, and vitamin C derived from consumption of nonalcoholic beverages.

In this light, specific objectives of this study are: 1) to determine the factors affecting calcium, caffeine, vitamin C, and caloric intake derived from at-home consumption of nonalcoholic beverages for the period 1998 through 2003; and 2) to ascertain the impact of the 2000 USDA Dietary Guidelines for Americans on the intake of calcium, caffeine, vitamin C, and calories derived from nonalcoholic beverages consumed at home from 1998 through 2003.

Organization

We initially discuss daily nutritional needs of individuals, and we review past studies conducted dealing with nutritional contributions of nonalcoholic beverages to the U.S. diet. Subsequently, we present the methodology used to address the aforementioned objectives. We provide a description of the econometric models, and we give a detailed description of the data used in the study. Furthermore, we provide the empirical results of the estimated econometric models followed by relevant policy implications. Finally, we make concluding remarks and provide some limitations of our study.

Dietary Role of Nonalcoholic Beverages

Daily intake of calories, calcium, and vitamin C can vary with gender, age, and physical activity level of an individual. For example, active 2–3 year olds may require up to 1,400 kcal per day regardless of their gender. An active male who is in the age category of 31–50 years may require up to 3,000 kcal per day. On average, calorie requirements are relatively lower for active females than active males by approximately 500 kcal per day (Dietary Guidelines for Americans, 2000 and 2005).

The daily calcium requirement grows with the age. On average, a healthy adult needs approximately 1,000 mg (1 g) of calcium per day (U.S. Department of Health and Human Services, 2004). Vitamin C also is a vital nutrient that is necessary in the daily diet. On average, an adult should get approximately 155 mg of vitamin C per day to maintain a healthy body (Center for Nutrition Policy Promotion, U.S. Department of Agriculture, 2005).

Unlike calcium and vitamin C, caffeine is an ingredient that should be consumed in moderation. According to the Surgeon General, excessive consumption of caffeine may interfere with calcium absorption (U.S. Department of Health and Human Services, 2004). Excess amounts of caffeine also may have deleterious effects on pregnancies, leading to miscarriages and impairment in the development of the fetal nervous system.

We now turn attention to past studies done on contributions of nonalcoholic beverages to the U.S diet and related government policy actions. Harnack, Stang, and Story (1999) studied nutritional consequences of soft drink consumption among U.S. children and adolescents. This study was limited to U.S. children aged 2–18 years during calendar years 1994 and 1995. The source of data for this analysis was the USDA Continuing Surveys of Food Intake by Individuals (CSFII). Caloric intake was found to be positively related to soft drink consumption, whereas milk and fruit juice consumption was negatively associated with soft drink consumption.

According to Gortmaker et al. (1993), adolescent and young adulthood obesity/overweight problems not only contributed to health-related risks, but also these problems have a deleterious effect on self-esteem and on educational attainment. They also found that adolescents were more likely to consume soft drinks than preschool- and school-aged children. White children consumed more soft drinks than black children, and boys consumed more soft drinks than girls. It was recommended that "dietetic professionals should inquire about soft drinks consumption when counseling children and ask parents to limit the amount of soft drinks brought into homes."

Gartner and Greer (2003) centered attention on the decline in milk consumption in America and the associated vitamin D deficiency among children. French, Lin, and Guthrie (2003) investigated the trends between 1977–1978 and 1994–1995 in the prevalence, amounts, and sources of soft drink consumption among U.S. children and adolescents (6–17 years of age) using data from three national surveys. They found that the prevalence of the soft drink consumption increased by 48% over this time period. Mean intake of soft drinks more than doubled from 5 fl oz to 12 fl oz per day. Furthermore, French, Lin, and Guthrie (2003) found that larger proportions of soft drinks were consumed at home compared with vending machines, restaurants, and school cafeterias.

Ahuja and Perloff (2001) examined the caffeine intake of U.S. children 9 years and younger using data from USDA CSFII for the period 1994–1996 and 1998. According to them, most widely consumed caffeine rich foods were coffee, tea, carbonated soft drinks, and chocolate. It was found that more children actually obtained caffeine from consuming chocolate than from consuming carbonated soft drinks; 44% of children consumed chocolate in comparison with 20% who drank carbonated beverages containing caffeine. Furthermore, it was found that white children consumed more caffeine than the black children.

Chanmugam et al. (2003) studied fat and energy (calories) intake by U.S. households during the period 1989–1991 and 1994–1996 using CSFII data. They found that one of the most important changes was the drop in whole milk consumption and an increase in the consumption of reduced-fat milk and carbonated soft drinks. Furthermore, they found that the higher caloric intake was the result of excessive consumption of carbonated soft drinks. This research reinforced the findings of a similar study by Guthrie and Morton (2000). The latter was done to identify food sources of added sweeteners in the U.S. diet. Guthrie and Morton (2000) used 1994–1996 CSFII data in their investigation. They found that during the period 1994–1996, Americans aged 2 years and older obtained 16% of their total caloric intake from consumption of added sweeteners. One-third of this intake came from consumption of regular soft drinks. Furthermore, Guthrie and Morton (2000) found that the percent contribution to added sweeteners intake from the consumption of soft drinks increased throughout the childhood and adolescence and peaked during the ages from 18–34 years for both men and women. The intake subsequently decreased steadily for older adults.

Capps et al. (2005) was the most comprehensive study done investigating the nutritional contribution of nonalcoholic beverages to the U.S. diet. The focus of their research was the nutrient availability from nonalcoholic beverages purchased for at-home consumption. Previous studies used data from the CSFII focusing on food and beverage intake based on individual recall over the 2 nonconsecutive days (within a 3-week period). Capps et al. (2005) used a scanner data set with demographics, namely the 1999 Nielsen Homescan Panel. The focus was on household purchases over an entire year recorded by at-home scanning technology provided by Nielsen. The Homescan Panel offered a potentially richer and more recent database for their study than the CSFII. According to their findings, daily calorie intake derived from nonalcoholic beverages was mainly determined by employment status and education level attained by the household head as well as race, region, and presence of children. Calcium and vitamin C intake derived from nonalcoholic beverages was lower for poverty households compared with nonpoverty households. Caffeine availability derived from nonalcoholic beverages was lower for blacks, Asians, and other races compared with whites. Using the daily values of the Nutrition Facts portion of the food label as a reference, this study found that for calendar year 1999, nonalcoholic beverages purchased for at-home consumption provided 10% of daily value for calories, 20% of the daily value for calcium, and 70% of daily value for vitamin C on a per-person basis.

The research by Capps et al. (2005) used data for calendar year 1999 only. In this study, we use similar scanner data but for 6 calendar years, from 1998 to 2003. With these data, we are able to consider patterns in calorie and nutrient intake derived from nonalcoholic beverage consumption over several years. In addition, we are in a position to address the effectiveness of USDA Dietary Guidelines[2] on beverage consumption set forth in year 2000.

Data Description

The source of the data for this analysis is the Nielsen Homescan panel data for calendar years 1998–2003. These data are taken from a sample of households that are demographically representative from various cities and rural markets within four regions of the United States (east, midwest, south, and west). Approximately 85% of households represented city markets and approximately 15% of households were from rural markets. Major city markets included Chicago, Los Angeles, New York, San Francisco, Atlanta, Philadelphia, Baltimore, Washington, DC, and San Antonio.

Each household was provided with a scanner machine in which they could scan and record all items purchased in different retail trade locations throughout a given time period. Panelists recorded the expenditure and quantity of all items purchased in that household followed by input of demographic information about the household. Demographic information included household size and income, age of the household head, age and presence of children, employment status of the household, race, region, and ethnicity (Hispanic origin).

Nielsen Homescan data include purchases of all consumer items bought by a household during a specified period of time. Importantly, the Nielsen data pertain to at-home purchases of food and beverage items. For our analysis, we used nationally representative data for at-home purchases of nonalcoholic beverage products only.

Initially, household purchases of nonalcoholic beverages were assimilated for each calendar year and converted into annual intake of calories, calcium, vitamin C, and caffeine. From this information, daily per-person intake of these nutritional elements subsequently was calculated by dividing by 365 and dividing this result further by household size. Nutrient information pertaining to calories, calcium, vitamin C, and caffeine was not directly included in Nielsen data. This information was obtained from USDA (see Appendix D of Pittman [2004] for nutrient conversions for nonalcoholic beverages). Units of measurement for calories are expressed in kilocalories per person per day, whereas calcium, vitamin C, and caffeine are expressed in milligrams per person per day. Finally, our data sample consists of 1,715 households, their beverage transactions, amounts of calories and nutrient intake, and demographic information traced from January 1998 through December 2003, hence a panel. In total, 10,290 observations (1,715 households across 6 years) are available for analyses. The use of this panel data set allows us to get a better handle of ascertaining the impact of the 2000 USDA Dietary Guidelines. We are in a position to track the behavior of these 1,715 households before and after the implementation of the 2000 USDA Dietary Guidelines.

Methodology

Econometric models are estimated using the Proc Panel procedure available in the econometric software package SAS 9.2 (SAS Institute Inc., Cary, NC). More specifically, we used a two-way random-effects model (for pooled cross-secl and time-series information or panel data) taking into account the Fuller-Battese error components procedure (Fuller and Battese, 1974) to capture the factors affecting the intake of calcium, caffeine, vitamin C, and calories derived through the at-home consumption of nonalcoholic beverages. Demographics, the price of nonalcoholic beverages, and poverty status of the household are hypothesized to affect the intake of each nutritional category. For each household, the price of nonalcoholic beverages is calculated as a weighted average price derived as the ratio between the sum of annual expenditures and the sum of annual quantities of all nonalcoholic beverages. The demographics considered include age of household head, employment status of household head, education status of household head, region, race, Hispanic origin, age and presence of children, gender of household head(s), and poverty status of household. As

[2] USDA published dietary guidelines for Americans with special emphasis on the consumption of carbonated soft drinks in 2000. In 2005, the dietary guidelines placed more emphasis on milk consumption.

well, we generate indicator variables corresponding to year to test for changes in intake associated with each nutritional category between calendar years 1998, 1999, and 2000 (the reference period) and calendar years 2001, 2002, and 2003. Poverty status is captured using an indicator variable pertaining to whether or not the household is above or below 185% of the poverty threshold. Poverty households are calculated by the U.S. Department of Health and Human Services, taking into account both income and household size.

Data Analysis

According to Table 1, on average for the 6-year period (1998–2003), at-home consumption of nonalcoholic beverages accounted for 242 kcal, 221 mg of calcium, 59 mg of vitamin C, and 94 mg of caffeine per person per day. To give this set of descriptive statistics more perspective, when average daily recommended values for each nutrition category are taken into account[3], the at-home consumption of nonalcoholic beverages is responsible for 12% of calories, 22% of calcium, 38% of vitamin C, and 47% of caffeine.

On average, the price of nonalcoholic beverages over the period 1998–2003 was $2.35 per gallon. Concerning demographics, over half of the sample pertains to household heads between the ages of 45 and 54 years and 55 and 64 years. Roughly 60% of household heads are employed, either part-time or full-time. Approximately 75% of household heads have at least some college education. In our sample, one-third of the households are located in the South, one-fourth of the households are located in the Midwest, on-fifth of the households are located in the West, and one-fifth of the households are located in the East. Furthermore, approximately 5% of the households are of Hispanic ethnicity. Roughly 25% of the households have children, either younger than 6 years, between 6 and 12 years, or between 13 and 17 years of age. Close to 90% of the households are white, 6% are black, 2% are Asian, and the remaining 3% of households are from other races. Approximately 70% of the households are headed by both male and female members, 20% are headed by males only, and 10% are headed by females only. Finally, in our sample, 8% of the households fell below 185% of the poverty threshold.

Econometric Analysis

In this section, we discuss the factors affecting the intake of calories, calcium, vitamin C, and caffeine derived from the at-home consumption of nonalcoholic beverages. We accomplish this task through the estimation of econometric models. Caffeine, calcium, vitamin C, and calorie intakes are regressed on the weighted average price of nonalcoholic beverages and the aforementioned sociodemographic factors for the period from 1998 through 2003.

The econometric model for each nutrient and for calories is given as follows:

$$(1)\quad Q_{ht} = f\left\{\begin{matrix} \textit{Price, Age of household head,} \\ \textit{Employment status of household head,} \\ \textit{Education status of household head, Region, Race,} \\ \textit{Hispanic status of household head,} \\ \textit{Age and presence of children,} \\ \textit{Gender of household head,} \\ \textit{Poverty status, Yearly, dummy variables} \end{matrix}\right\} + V_{ht}$$

where h relates to households and t relates to the year (1998, 1999, 2000, 2001, 2002, and 2003); Q_{ht} corresponds to the amount of caloric intake (kilocalories per person per day), and nutrient intake (caffeine, calcium, and vitamin C in milligrams per person per day) derived from the

[3] Average daily recommendation for calories is 2000 kcal per person per day (to be in par with Nutrition Facts Panel of food and beverage labels); calcium is 1000 mg per person per day; vitamin C is 155 mg per person per day; caffeine is approximately 200 mg per person per day (caffeine is not considered a required nutrient).

Table 1. Summary Statistics of Variables Considered in the Study

Variable[a]	Mean	Standard Deviation	Minimum	Maximum
Calories (kcal/person/day)	242.37	159.02	1.74	2121.74
Calcium (mg/person/day)	221.01	175.80	1.00	2138.31
Vitamin C (mg/person/day)	59.14	54.12	0.01	785.94
Caffeine (mg/person/day)	94.30	104.29	0.04	1444.00
Price (dollars/gallon)	2.35	0.71	0.55	9.69
Sociodemographic Information	**Mean**	**Number of Observations**		
Less than 25 years (base category)	0.00[b]	31		
Age of household head between 25 and 29 years	0.01	123		
Age of household head between 30 and 34 years	0.04	360		
Age of household head between 35 and 44 years	0.20	2058		
Age of household head between 45 and 54 years	0.29	2943		
Age of household head between 55 and 64 years	0.25	2614		
Age of household head older than 64 years	0.21	2161		
Not employed for pay (base category)	0.39	3993		
Household head employed part-time	0.17	1739		
Household head employed full-time	0.44	4558		
Less than high school (base category)	0.02	216		
Education of household head: high school only	0.22	2212		
Education of household head: undergraduate only	0.63	6555		
Education of household head: some postcollege	0.13	1307		
East (base category)	0.19	1986		
Region: Central (Midwest)	0.27	2819		
Region South	0.33	3344		
Region West	0.21	2140		
White (base category)	0.89	9158		
Race black	0.06	628		
Race Asian	0.02	175		
Race other (nonblack, nonwhite, non-Asian)	0.03	329		
Non-Hispanic ethnicity (base category)	0.95	9806		
Hispanic ethnicity	0.05	484		
No child younger than 18 years (base category)	0.77	7985		
Age and presence of children younger than 6 years	0.03	257		
Age and presence of children between 6 and 12 years	0.06	576		
Age and presence of children between 13 and 17 years	0.07	720		
Age and presence of children younger than 6 and 6–12 years	0.02	226		
Age and presence of children younger than 6 and 13–17 years	0.00[b]	41		
Age and presence of children between 6–12 and 13–17 years	0.04	432		
Age and presence of children younger than 6, 6–12, and 13–17 years	0.01	51		
Both male and female (base category)	0.70	7234		
Household head male only	0.20	2068		
Household head female only	0.10	988		
Above 185% poverty (base category)	0.92	9477		
Below 185% poverty households	0.08	813		

Source: Nielsen Homescan Panel data for 1,715 households, 1998 to 2003, a total of 10,290 observations.

[a] Standard deviation, minimum and maximum values are recorded for continuous variables. For the sociodemographic information (discrete variables), we recorded only the mean and number of observations. The means of these respective variables provide the percentage of the total sample which coincides with the specific demographic characteristic.

[b] Less than 0.01.

at-home consumption of nonalcoholic beverages for a given time period.

Given the panel structure of the data, we used the Fuller-Battese error components procedure (Fuller and Battese, 1974) as a generalized least squares estimation technique. With this procedure, the error or disturbance term v_{ht} is assumed to be composed of three independent components associated with time periods, cross-secl units, and random elements. That is,

$$(2)\qquad v_{ht} = u_h + v_t + w_{ht},$$

where h corresponds to households and t corresponds to year. Essentially, the Fuller-Battese procedure corresponds to a two-way random effects model. The variance of v_{ht}, var(v_{ht}), under assumptions set forth by Fuller and Battese (1974), subsequently may be written as:

$$(3)\qquad var(v_{ht}) = \sigma^2 = \sigma_u^2 + \sigma_v^2 + \sigma_w^2.$$

σ_u^2 is the variance of the cross-secl component, σ_v^2 is the variance of the time component, and σ_w^2 is the variance of the random component. The variance–covariance matrix of the disturbance terms may be expressed as:

$$(4)\qquad \sum = \begin{bmatrix} \sigma_u^2 A_T & \sigma_v^2 I_T & \dots & \sigma_v^2 I_T \\ \vdots & \vdots & & \vdots \\ \sigma_v^2 I_T & \sigma_u^2 A_T & \dots & \sigma_v^2 I_T \\ \vdots & \vdots & & \vdots \\ \sigma_v^2 I_T & \sigma_v^2 I_T & \dots & \sigma_u^2 A_T \end{bmatrix},$$

where I_T is an identity matrix of order 6×6 (6 years) and where A_T is a matrix defined as:

$$(5)\qquad A_T = \begin{bmatrix} \sigma^2/\sigma_u^2 & 1 & \dots & 1 \\ \vdots & \vdots & & \vdots \\ 1 & \sigma^2/\sigma_u^2 & \dots & 1 \\ \vdots & \vdots & & \vdots \\ 1 & 1 & \dots & \sigma^2/\sigma_u^2 \end{bmatrix}.$$

Using the Proc Panel procedure in the software package SAS 9.2, generalized least squares estimates and standard errors of the parameters associated with the right-hand side variables in equation (1) are obtained along with estimates of σ_u^2, σ_v^2, and σ_w^2 (and consequently, σ^2).

As pointed out by one reviewer, the use of the right-hand side variable corresponding to the weighted average price of all nonalcoholic beverages could induce endogenicity. To examine for possible endogenicity effects, especially in the absence of proper instruments, on the use of the previously described estimation procedure, we ran correlations of residuals with the respective price variables. For each of the four equations, very small correlations among the residuals and the price variables were found. Given the very small magnitudes of theses correlations ranging from –0.0338 to 0.0681, we conclude that endogenicity associated with price is indeed negligible. Consequently, given this result and the lack of instruments for the price variable, there is no need to conduct a formal Hausman test (Hausman, 1978) associated with the price endogeniety issue.

We considered different functional forms such as linear, linear-log, quadratic, log-log, and log-linear. We found that the quadratic functional form outperformed other functional forms based on Box-Cox transformations. The level of significance chosen for this analysis is 0.05.

It is noteworthy to address the marginal impact of price on the level of caloric or nutrient intake given the fact that a quadratic functional form is used for the econometric models. Let the intake of calories, calcium, caffeine, and vitamin C be denoted by Q_i. The quantity of nonalcoholic beverages associated with each of the respective intake is represented by Q_{NAB}. P_{NAB} is the weighted average price of nonalcoholic beverages. Then it follows that:

$$(6)\qquad \frac{\partial Q_i}{\partial P_{NAB}} = \frac{\partial Q_i}{\partial Q_{NAB}} * \frac{\partial Q_{NAB}}{\partial P_{NAB}}$$

In words, the change of intake of calories and other nutrients with respect to a change of price of nonalcoholic beverages (i.e., $\frac{\partial Q_i}{\partial P_{NAB}}$) can be decomposed into the product of change of intake of calories and other nutrients as a result of a change in the quantity consumed of nonalcoholic beverages (i.e., $\frac{\partial Q_i}{\partial Q_{NAB}}$) as well as the change in the quantity consumed of nonalcoholic beverages as a result of a change in price of the corresponding nonalcoholic beverage category (i.e., $\frac{\partial Q_{NAB}}{\partial P_{NAB}}$). Considering all nonalcoholic beverages as a single good, from the law of demand we know that $\frac{\partial Q_{NAB}}{\partial P_{NAB}}$ must have a negative sign (the own-price effect). As the quantity of nonalcoholic beverages consumed changes, caloric and nutrient (calcium, caffeine, and vitamin C) intake may increase, decrease, or remain the same. That is, the sign of $\frac{\partial Q_i}{\partial Q_{NAB}}$ depends on the composition of the nonalcoholic beverages consumed. Therefore, the sign of $\frac{\partial Q_i}{\partial P_{NAB}}$ is indeterminate.

To demonstrate the impact on the price derivative, $\frac{\partial Q_i}{\partial P_{NAB}}$ on caloric intake, let us assume a rise in the price of sugar-sweetened nonalcoholic beverages (all other factors invariant) by a given proportion. As a result, there is a concomitant reduction of the quantity of sugar-sweetened nonalcoholic beverages (such as isotonics, regular soft drinks, fruit juices, fruit drinks, and sweetened coffee and tea). That is, $\frac{\partial Q_{NAB}}{\partial P_{NAB}} < 0$. Because sugar-sweetened nonalcoholic beverages are loaded with calories, also, we would see a decrease in the caloric intake associated with the reduction of consumption of sugar-sweetened nonalcoholic beverages. Consequently, we expect then that $\frac{\partial Q_i}{\partial Q_{NAB}} > 0$. Overall we would see a negative sign for $\frac{\partial Q_i}{\partial P_{NAB}}$ as a consequence.

We spent time vetting the issue of whether market shares associated with beverage consumption, both at home and away from home, changed over the period of our analysis. The importance of this issue lies in the fact that the Nielsen data only allow us to capture at-home consumption of nonalcoholic beverages. If market shares of nonalcoholic beverages for at-home vs. away-from-home consumption changed notably over the period 1998–2003, then this change taints our ability to ascertain the impact of the dietary guidelines. Put more succinctly, changes in calorie and nutrient intakes after the implementation of the 2000 Dietary Guidelines may have been attributable in part to the change in market shares of nonalcoholic beverages for at-home vs. away-from-home consumption.

We considered various sources, including reports and data from the Beverage Marketing Corporation. In a nutshell, for beverages, we were not able to find much information regarding market shares of nonalcoholic beverages for at-home vs. away-from-home consumption. We recognize that over the period January 1998 through December 2003, expansion of coffeehouses (notably Starbucks) as well as supersizing of soft drinks at fast-food restaurants and convenience stores took place. Nevertheless, the USDA calculates and reports the share of the dollar for at-home and away-from-home food expenditures going back to 1900. The share of the at-home and away-from-home food dollar was very consistent over the period 1998–2003, approximately 52% for food at home and 48% for food away from home. Consequently, we are reasonably confident in making the claim that any changes in calorie and nutrient intake are *not* attributed to changes in market shares of nonalcoholic beverages for at-home or away-from-home consumption.

Empirical Results

We now provide a discussion of each of the econometric results for calories, calcium, caffeine, and vitamin C derived from consumption of nonalcoholic beverages. Emphasis is placed on the factors affecting the intake as well as differences in intake between the years 1998, 1999, and 2000 (the reference period) and the years 2001, 2002, and 2003. Consequently, we are in a position to determine whether or not the implementation of the Dietary Guidelines in 2000 was effective in bringing about desired changes in caloric and nutrient intake.

In Table 2, we present the econometric results concerning intakes of calories, vitamin C, calcium, and caffeine derived from the at-home consumption of nonalcoholic beverages over the period 1998–2003. Separate discussions associated with factors affecting calories, calcium, caffeine, and vitamin C are elaborated in subsequent sections. As exhibited in Table 2, the goodness-of-fit (R^2) measures range from 0.0418 (calcium) to 0.1695 (caffeine). These measures are typical for analyses associated with panel data. Additionally, in Table 2, owing to the use of the Fuller-Battese procedure, we report the variance components for cross-sections, time-series, and random error. Not surprisingly, most of the variability in the disturbance terms is attributed to the cross-secl components and random components resulting from the predominance of the number of households relative to the number of time periods.

Table 2. Econometric Results from Caloric, Calcium, Caffeine, and Vitamin C Intake, 1998–2003

Right-Hand Side Variable	Category Explanation	Calories	Calcium	Vitamin C	Caffeine
	Intercept	**192.23**	**157.58**	**28.97**	**314.64**
		(0.0001)	(0.0001)	(0.0091)	(0.0001)
Price	Price	**20.97**	**15.44**	**14.54**	**−134.30**
		(0.0023)	(0.0263)	(0.0001)	(0.0001)
	Price squared	–1.79	**–3.43**	–0.49	**14.50**
		(0.1096)	(0.0023)	(0.2009)	(0.0001)
Age	*Less than 25 years (base category)*				
Household head	25–29 years	**66.40**	45.41	14.98	11.20
		(0.0108)	(0.0821)	(0.0920)	(0.4924)
	30–34 years	**68.11**	**70.58**	15.05	6.71
		(0.0131)	(0.0107)	(0.1076)	(0.6957)
	35–44 years	**55.23**	**66.55**	12.32	14.16
		(0.0449)	(0.0166)	(0.1887)	(0.4099)
	45–54 years	39.18	**62.52**	9.28	18.07
		(0.1550)	(0.0247)	(0.3218)	(0.2929)
	55–64 years	36.01	**61.24**	9.32	16.93
		(0.1939)	(0.0289)	(0.3224)	(0.3270)
	Older than 64 years	24.97	**57.74**	8.88	6.39
		(0.3734)	(0.0422)	(0.3513)	(0.7145)
Employment status	*Not employed for pay (base category)*				
Household head	Employed part-time	**–16.74**	**–15.84**	**–5.81**	**−4.68**
		(0.0001)	(0.0002)	(0.0001)	(0.0738)
	Employed full-time	**–20.36**	**–21.87**	**–4.80**	−1.65
		(0.0001)	(0.0001)	(0.0007)	(0.5221)
Education status	*Less than high school (base category)*				
Household head	High school only	10.93	7.20	5.25	6.66
		(0.4089)	(0.5974)	(0.2403)	(0.4147)
	Undergraduate only	–10.80	–6.62	1.64	0.95
		(0.4245)	(0.6371)	(0.7191)	(0.9091)
	Some postcollege	–9.99	–8.26	6.33	−0.84
		(0.5041)	(0.5963)	(0.2088)	(0.9272)
Region	*East (base category)*				
	Central (Midwest)	1.25	**33.33**	**–12.56**	−7.43
		(0.8905)	(0.0012)	(0.0001)	(0.1698)
	South	–2.48	9.65	**–10.92**	−8.72
		(0.7753)	(0.3235)	(0.0001)	(0.0923)
	West	**–24.95**	11.93	**–17.61**	−2.67
		(0.0098)	(0.2730)	(0.0001)	(0.6428)
Race	*White (base category)*				
	Black	17.42	**–63.10**	**20.23**	**−13.96**
		(0.1058)	(0.0001)	(0.0001)	(0.0323)
	Asian	–28.04	**–41.67**	–1.78	**−21.72**
		(0.0521)	(0.0052)	(0.7143)	(0.0147)
	Other	6.87	–13.27	**6.36**	**−19.29**
		(0.4210)	(0.1252)	(0.0283)	(0.0003)

Table 2. Continued

Right-Hand Side Variable	Category Explanation	Calories	Calcium	Vitamin C	Caffeine
Hispanic status	*Non-Hispanic ethnicity (base category)*				
	Hispanic	6.62	3.59	–1.09	5.85
		(0.5048)	(0.7278)	(0.7447)	(0.3381)
Age and presence of children	*No children younger than 18 years (base category)*				
	Younger than 6 years	**–44.83**	**–18.19**	**–16.75**	**−32.41**
		(0.0001)	(0.0247)	(0.0001)	(0.0001)
	Between 6 and 12 years	**–72.32**	**–57.18**	**–20.72**	**−31.34**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Between 13 and 17 years	**–19.98**	**–13.57**	**–10.92**	**−15.58**
		(0.0002)	(0.0109)	(0.0001)	(0.0001)
	Younger than 6 and 6–12 years	**–68.41**	**–41.87**	**–23.17**	**−35.64**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Younger than 6 and 13–17 years	**–80.29**	**–59.42**	**–20.02**	**−38.18**
		(0.0001)	(0.0007)	(0.0008)	(0.0005)
	Between 6–12 and 13–17 years	**–62.31**	**–53.69**	**–18.83**	**−29.96**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Younger than 6, 6–12, and 13–17 years	**–70.76**	**–59.82**	**–20.51**	**−33.16**
		(0.0001)	(0.0006)	(0.0005)	(0.0021)
Gender	*Both male and female (base category)*				
Household Head	Male only	**36.40**	**30.30**	**8.90**	**28.40**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
	Female only	**136.37**	**102.51**	**36.64**	**44.14**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Poverty status	*Above 185% poverty (nonpoverty households) (base category)*				
	Below 185% poverty	0.54	–8.09	–0.29	0.58
		(0.9204)	(0.1275)	(0.8724)	(0.8595)
Yearly dummy	*Indicator variable for 1998, 1999, and 2000 (base category)*				
	2001	–7.83	**–12.07**	–0.35	1.53
		(0.0523)	(0.0105)	(0.6661)	(0.3879)
	2002	**–38.94**	**–36.20**	**–8.79**	**−12.34**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
	2003	**–44.68**	**–41.47**	**–10.34**	**−8.86**
		(0.0001)	(0.0001)	(0.0001)	(0.0001)
Goodness-of-fit	R^2	0.0639	0.0418	0.0780	0.1695
Variance component for cross-section (σ_u^2)		16,579.09	22,358.43	1,770.12	5,795.93
Variance component for time-series (σ_v^2)		8.00	12.47	0.00	0.72
Variance component for random error (σ_w^2)		6,844.58	6,789.02	803.83	2,728.90

Note: p values are in parentheses below each estimated coefficient. Coefficients that are in bold font are statistically significant at the 5% level.

Factors Affecting Caloric Intake

Price, age of household head, employment status of household head, and education status of the household, region, race, age and presence of children, and gender of the household food manager are significant factors determining the intake of calories from at-home consumption of nonalcoholic beverages.

Owing to the quadratic functional form, the marginal effect of price on caloric intake is a function of price, namely $20.97 - 3.58 * Price$. Given that the average price paid for nonalcoholic beverages during the period in question is $2.35 per gallon, this marginal impact is positive.

Households where the household head is between 30 and 34 years of age, intake of the highest amount of calories (55.23 kcal more compared with households with household heads younger than 25 years) was derived from consumption of nonalcoholic beverages compared with all other age categories.

Households in which household head is employed full-time or part-time have significantly lower caloric intake in comparison with those households in which the household head is not employed for pay (this includes household heads who are not employed as well as who perform voluntary activities). In particular, this intake is lower by approximately 17 and 20 kcal per person per day for full-time- and part-time-employed household heads, respectively.

The more educated the household head, the lower the caloric intake by consuming nonalcoholic beverages. This intake is approximately 10 kcal lower for those households that have some postcollege education compared with those households with less than a high school education. As well, caloric intake is lower by approximately 11 kcal for those households have some college education compared with those households with less than a high school education.

Households located in the West consume approximately 25 kcal per person per day less calories than those located in the East. Asian households consume approximately 28 kcal per person per day less than those households classified as white.

Age and presence of children also is a significant factor in determining the caloric intake derived from nonalcoholic beverages. More specifically, caloric intake is lower for those households with children compared with those without children. Households headed by a male consume approximately 36 kcal per person per day more than those households headed by both a male and a female.

Factors Affecting Caffeine Intake

Statistically significantly factors affecting caffeine intake are price, race, age and presence of children, and gender of the household head. The marginal effect of price on caffeine intake is expressed as $-134.30 + 29 * Price$. Given that the average price of nonalcoholic beverages over the 1998–2003 period is $2.35 per gallon, this marginal impact is negative. From this finding, one may calculate the weighted average price of nonalcoholic beverages to minimize caffeine intake. This price turns out to be $4.63 per gallon.

Intake of black and Asian households is lower by 14 and 22 mg, respectively, than caffeine intake of white households. Households with children have lower caffeine intake per person per day than those households without children. Intake of households headed by a male only and intake of households headed by a female only are higher by 28 mg and by 44 mg, respectively than those households headed by both males and females.

Factors Affecting Calcium Intake

Price, age of household head, employment status of the household head, region, race, Hispanic origin, age and presence of children, and gender of household head are significant drivers of calcium intake derived from consumption of nonalcoholic beverages. The marginal effect of price on calcium intake is given as $15.44 - 6.86 * Price$. Given that the average price paid for nonalcoholic beverages is $2.35 per gallon over the period 1998–2003, this marginal impact is negative. From this result, the price of nonalcoholic beverages associated with the maximum intake of calcium is $2.25 per gallon with all other factors invariant.

Households where household head is 64 years and older shows the second lowest amount of calcium intake derived from consumption of nonalcoholic beverages at home. Households in which the household head is employed full-time or part-time have a lower intake of calcium from beverages compared with those of households where the household head is not employed for pay. Households located in the Midwest have a higher intake of calcium (approximately 33 mg) than households located in the East. Calcium intake of blacks, Asians, and other races are much lower than those of whites. In particular, intake of calcium for blacks is approximately 63 mg lower than for whites; intake of calcium for Asians and other races also is lower by 42 and 13 mg compared with whites.

Presence of children in a household significantly reduces the calcium intake derived from consumption of nonalcoholic beverages. Calcium intake of households headed by a male only is lower per person per day than those households headed by both a male and a female.

Factors Affecting Vitamin C Intake

Significant factors that are affecting the intake of vitamin C are price, employment status of the household head, region, race, age and presence of children, and gender of the household food manager. The marginal effect of price on vitamin C intake is given as $14.53 - 0.98 * Price$. Given that the average price paid for nonalcoholic beverages is $2.35 per gallon over the 1998–2003 period, this marginal impact is positive, just as in the case of calories.

Full-time (part-time)-employed household heads consume 7 mg (6 mg) of vitamin C less in comparison with those who are not employed for pay. The highest vitamin C intake is among households located in the East. More specifically, this intake is higher by approximately 18 mg compared with that of households located in the West and approximately 11 mg higher relative to those located in the Midwest and in the South.

Intake of vitamin C derived from nonalcoholic beverages is higher for households without children than for households with children. Households headed by males only have intake of vitamin C that are higher by 9 mg compared with households headed by both males and females.

Impact of USDA Dietary Guidelines on Caloric, Caffeine, Calcium, and Vitamin C Intake

According to Table 2, per-capita caloric intake per day derived from consumption of nonalcoholic beverages at home is significantly lower in years 2001–2003 compared with that of years 1998–2000. In 2001, caloric intake was lower by 8 kcal per person per day and lower by approximately 39 and 45 kcal per person per day in years 2002 and 2003, respectively, compared with that of the reference period, 1998–2000. This result sheds light on the effectiveness of the USDA year 2000 Dietary Guidelines designed in part to reduce the intake of beverages to moderate the intake of sugars, and, hence, extra calories.

As shown in Table 2, per-capita caffeine intake per day derived from consumption of nonalcoholic beverages at home is significantly lower in years 2002–2003 compared with that of in years 1998, 1999, and 2000. This finding is on par with the expectations of the USDA year 2000 Dietary Guidelines and food guide pyramid, in which it is advised to curtail the intake of caffeinated beverages and concentrate more on decaffeinated diet soft drinks (with low added sugar content) as beverage choices.

As exhibited in Table 2, per-capita calcium intake is lower by 12, 36, and 41 mg in years 2001, 2002, and 2003, respectively, in contrast to that of in years 1998, 1999, and 2000. The USDA 2000 Dietary Guidelines for Americans recognize the importance of calcium intake either from food/beverages sources or from supplements. However, there may be reasons for the decline in calcium intake derived through consumption of nonalcoholic beverages at home. First, there is a possibility that while consumers are trying to reduce the intake of calories and caffeine by cutting back on the consumption of nonalcoholic beverages, intake of calcium drops as a consequence. Second, we may assume that consumers may be substituting away from nonalcoholic beverages to nonbeverage choices for calcium intake. According to the USDA 2000 Dietary Guidelines, some of the other alternative calcium sources are yogurt, cheese, soy-based products with added calcium, tofu made with calcium sulfate, breakfast cereal with added calcium, canned fish with soft bones such as salmon and sardines, and dark green vegetables (collards, turnip greens). Third, some consumers may satisfy their daily calcium intake through supplements and simultaneously move away from nonalcoholic beverages. Finally, our study captures only at-home consumption of nonalcoholic beverages and ignores the consumption of nonalcoholic beverages away from home.

As depicted in Table 2, intake of vitamin C is lower by approximately 12 mg and 10 mg per day, respectively, for years 2001, 2002, and 2003 compared with that of years 1998, 1999, and 2000. Possible reasons we may conjecture for the decline in the intake of vitamin C may be the following. First, decreased consumption of fruit juices and drinks (powdered soft drinks like fruit ades and fruit punch) occurred to reduce the intake of added sugars, thus extra calories. Second, just as in the case with calcium, consumers may be substituting away from nonalcoholic beverage choices. Although the USDA 2000 Dietary Guidelines advocate the intake of citrus juices as a means of vitamin C intake, they also place a greater weight on obtaining vitamin C through the consumption of a wide variety of fresh fruits and vegetables such as citrus fruits, kiwi fruit, strawberries, cantaloupe, broccoli, tomatoes, and leafy greens like spinach. Third, some consumers may opt for supplements rather than depending on nonalcoholic beverages. Finally, again, our study revolves only around at-home consumption, ignoring away-from-home consumption of nonalcoholic beverages.

Concluding Remarks

Our findings demonstrate the nutritional contribution of nonalcoholic beverages consumed at home to the U.S. diet. Beverage choices made by households have impacts on determining the intake of calories, calcium, caffeine, and vitamin C on a daily basis. Price, age of household head, gender, and employment status of the household head, region, race, age, and the presence of children were statistically important in the determination of daily caloric intake from the consumption of nonalcoholic beverages. Statistically significant factors in determining the daily calcium intake derived from nonalcoholic beverages for the same time period are price, employment status, and gender of the household head, race, year, age, and presence of children. Employment status, gender of the household head, race, region, and presence of children were the key drivers associated with daily availability of vitamin C. Race, age, presence of children, and gender of household head were primary determinants of daily caffeine intake per person.

When yearly dummies were used to ascertain the impact of year 2000 USDA Dietary Guidelines, we found that there were significant drops in caloric, calcium, vitamin C, and caffeine in years 2001, 2002, and 2003 compared with that of 1998, 1999, and 2000, our reference years. That is to say, the 2000 USDA Dietary Guidelines have been successful in reducing caloric and caffeine intake derived from nonalcoholic beverage consumption at home. The reduction in calcium intake may be the result of the decline in milk consumption, substituting away from nonalcoholic beverages to food products such as cheese and yogurt and the use of supplements. The drop in vitamin C intake derived from nonalcoholic beverages consumption probably is the result of the fact that USDA Dietary Guidelines emphasized eating fresh fruits and vegetables compared with drinking nonalcoholic beverages. Also, consumers may obtain vitamin C from supplements, and consumers may cut back on high-calorie fruit juices and fruit drinks. Although attention is centered on the impact of the 2000 Dietary Guidelines as a result of data considerations, our methodological approach may be adapted to address the effectiveness of the 2005 or 2010 Dietary Guidelines subject to data availability. Thus, we provide a sound methodological approach that may be used to evaluate government intervention programs such as the Dietary Guidelines applicable to the consumption of nonalcoholic beverages.

Study Limitations

Limitations exist in our analysis warranting attention. Our study concentrates on at-home consumption of nonalcoholic beverages. The away-from-home intake of beverages is not accounted for in our analysis. Also, our analysis does not capture the substitution away from beverage choices to nonbeverage choices such as consumption of fresh fruits and vegetables. As well, intake from the use of dietary supplements is not captured. Nonetheless, this study demonstrates to some degree the effectiveness of the USDA intervention program, the 2000 Dietary Guidelines, in reducing intake of calories and nutrients derived from the consumption of nonalcoholic beverages.

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