Effects of Socioeconomic and Demographic Factors on Consumption of Selected Food Nutrients

Rodolfo M. Nayga, Jr.

The effects of socioeconomic and demographic factors on the consumption of food energy, protein, vitamin A, vitamin C, thiamin, riboflavin, niacin, calcium, phosphorus, and iron are examined. Socioeconomic and demographic factors analyzed are urbanization, region, race, ethnicity, sex, employment status, food stamp participation, household size, weight, height, age, and income. Several of these factors significantly affect consumption of certain nutrients. Income is an important factor affecting the consumption of vitamin A, vitamin C, and calcium. Income elasticities are relatively small at low income levels. For example, income elasticities range from 0.016 for calcium to 0.123 for vitamin C at an income level of $20,000.

Introduction

Increased interest in nutrition and health has heightened the need for a more complete understanding of nutrient consumption patterns (Adrian and Daniel, p. 31). Analysis of nutrient consumption provides information for a number of critical purposes, including the assessment of dietary status and development of nutrition education messages and policies (Windham et al.).

Many factors are believed to be influencing the eating patterns of Americans. The socioeconomic and demographic structure of the United States (U.S.) population has changed dramatically since the end of World War II with respect to urbanization, racial mix of the population, age and income distribution, and size of households (McCracken and Brandt). In particular, average household size has been falling; the percentage of the population in older age categories has been increasing; population growth has shifted to the south and west; and per capita income has risen. These changes, along with increased emphasis on health and nutrition, have altered dietary patterns.

Knowledge of the influence of socioeconomic and demographic factors on nutrient consumption are important, especially in the design and practical implementation of nutrition outreach programs. For instance, the relationship between certain socio-demographic factors and the consumption of a certain nutrient can be evaluated, and knowlege of these relationships can be utilized to develop nutrition education programs that focus on certain groups of individuals that consume unacceptable levels of certain nutrients.

Several previous studies have focused on providing information on the effects of socio-demographic factors and domestic food programs on nutrient intake (see Literature Review section below). Despite a considerable literature on nutrient consumption, Devaney and Moffitt acknowledged that the empirical results reported in various studies differ. Many of these studies have used relatively older data sets (e.g. 1977–78 NFCS) and have been limited to particular subgroups of people (e.g. elderly, low income) and localized areas.

The objective of this paper is to determine the effects of socioeconomic and demographic factors on nutrient intake of persons in the U.S. and to compare results with those of previous studies. This study provides information on the dietary effects of socioeconomic and demographic factors on nutritional intake of individuals.

Literature Review

A summary of selected studies on nutrient consumption is presented in Table 1. Cross-sectional

Assistant Professor, Department of Agricultural Economics and Marketing, Rutgers University. The author wishes to acknowledge helpful comments made by three anonymous journal reviewers. The author is also grateful to Maurice Hartley for some valuable suggestions and editorial assistance.

data sets are used in these studies to assess dietary quality and the impacts of various government programs on the levels of nutrient intakes (e.g., Lane; Price et al.; Davis and Neenan; Akin, Giulkey, and Popkin; Chavas and Keplinger; Scearce and Jensen; Devaney and Fraker; Devaney and Moffitt; Basiotis et al.). Common nutrients considered are iron, vitamin A, vitamin C, and calcium. The sociodemographic factors commonly included in the analyses are income, household size, ethnicity, and urbanization. The influence of these sociodemographic factors on nutrient levels varies across samples and model specifications. Evidence also exists, in most instances, to indicate that participation in government food assistance programs (e.g., Food Stamp Program; National School Lunch Program; National School Breakfast Program; Women, Infants, and Children Program) leads to increases in the levels of nutrient intakes, all other factors held constant.

Two articles (Adrian and Daniel; Windham et al.) are of interest to this study for the purpose of comparison. In 1976, Adrian and Daniel used the 1965–66 NFCS data set to estimate the impacts of socioeconomic factors on weekly household consumption of protein, carbohydrate, fat, vitamin A,

Table 1. Selected Studies on Nutrient Consumption Analysis

Researcher	Data Set[a]	Nutrients Considered[b]	Sociodemographic Factors Considered
Price, West, Schier, Price	Washington State children	10: Th, Rb, Ni, FE, Pr, Ca, Ph, Iron, VA, VC	Household size, region, urbanization, ethnicity
Akin, Guilkey, Popkin	1977–78 NFCS (Basic sample) School-age children	5: FE, VB_6, Iron, VA, VC	Urbanization, income, household size, race, ethnicity
Chavas, Keplinger	1977–78 NFCS (Spring portion—low income persons)	12: FE, Pr, Ca, Th, Iron, Rb, VB_6, VB_{12}, VC, Ph, VA, Ni	Income, ethnicity, education, household size, race
Scearce, Jensen	1972–73 BLS, CES (low-income families)	9: FE, Pr, Ca, Iron, VA, VB_1, VB_2, Ni, VC	Education, urbanization, income, lifecycle stage, race, household size
Devaney, Fraker	1980–81 cross-sectional survey of students, 1980–81 household survey of parents	7: FE, Chol, VB_6, VA, Iron, Ca, Mg	Race, ethnicity, education, employment status, region, household size, urbanization
Adrian, Daniel	1965–66 NFCS	8: Pr, Carb, Fat, VA, Ca, Iron, Th, VC	Income, family size, urbanization, life cycle stage, race, education, employment
Lane	1972 survey of households in Kern County, CA (low-income)	9: FE, Pr, Ca, VA, VC, Iron, Ni, Rb, Th	
Davis, Neenan	1976 EFNEP and cross-sectional survey of households in central Florida	5: Pr, Ca, Iron, VA, VC	Income, household size, life cycle family composition, ethnicity, employment, urbanization, education
Windham, Wyse, Hansen, Hurst	1977–78 NFCS	15: Pr, FE, Fat, Carb, Ca, Iron, Mg, Ph, VA, Th, Rb, Ni, VB_6, VB_{12}, VC	Region, urbanization, income, household size, race, employment education
Devaney, Moffitt	1979–80 Survey of Food Consumption in Low-Income Households (SFC-LI)	11: FE, Pr, VA, VC, Th, Rb, VB_6, Ca, Ph, Mg, Iron	Income, race, household size, region, ethnicity, urbanization, age
Basiotis, Brown, Johnson, Morgan	1977–78 NFCS (low income)	8: Iron, Pr, Ca, FE, Rb, Th, VC, VA	Household size & composition, urbanization, race, income, region

[a]NFCS = National Food Consumption Survey. BLS, CES = Bureau of Labor Statistics, Consumer Expenditure Survey. EFNEP = Expanded Food and Nutrition Education Program.
[b]FE = food energy, Pr = protein, VA = vitamin A, VB_1 = vitamin B_1, Th = thiamin, Ca = calcium, VC = vitamin C, VB_2 = vitamin B_2, Rb = riboflavin, Ph = phosphorus, VB_6 = vitamin B_6, Chol = cholesterol, Ni = niacin, Iron = iron, VB_{12} = vitamin B_{12}, Mg = magnesium, Fat = total fats, Carb = carbohydrate.
Note: A portion of this table was taken from Capps and Schmitz.

calcium, iron, thiamin, and vitamin C. The socioeconomic factors considered were income, degree of urbanization, race, educational attainment of the homemaker, stage of the household in the family life cycle, family size, meal adjustment, and employment status of the homemaker. They found that income was a significant factor affecting the consumption of all nutrients analyzed except carbohydrate. Nutrient consumption responsiveness to income, however, was relatively small. The results of this study also indicated that urban and rural households consumed smaller quantities of all nutrients analyzed except vitamins A and C than do farm households. Black households consumed less carbohydrate, calcium, and thiamin than do white or other race households.

In 1983, Windham et al. explored the relationships between some demographic and socioeconomic characteristics of individuals and the nutrient density of their diets. Using the 1977–78 NFCS data set, regression analysis was employed to test the effects of various socioeconomic and demographic factors on the nutrient density consumption of food energy and 14 nutrients. The nutrients analyzed are protein, fat, carbohydrate, calcium, iron, magnesium, phosphorus, vitamin A, thiamin, riboflavin, niacin, vitamin B_6, vitamin B_{12}, and vitamin C. The results of this study indicated that geographic region of the place of residence and race or ethnic origin of individuals were significant factors affecting calcium intake. Results also suggested that nutrient intake did not vary with income level.

Model

Following Nayga and Capps, the basic model of consumption for specific nutrients resembles the Engel function, which relates changes in the consumption of a good to changes in income. This function can be derived from consumer theory by assuming that a consumer chooses a consumption bundle so as to maximize utility subject to a budget constraint. Maximizing a consumer's utility subject to the budget constraint will lead to consumption functions for commodities:

$$q_i = f_i(p, y), \tag{1}$$

where p denotes a vector of prices; y is consumer income; and q_i is the consumption of the ith commodity. By extending this model to examine the consumption of nutrients, the intake of a certain nutrient is given by:

$$N = \Sigma_j a_j q_j, \tag{2}$$

where a_j denotes the amount of nutrients contained in each unit of commodity q_j. Substituting equation (1) into equation (2) leads to the nutrient consumption function of the following form:

$$N = g(p,y). \tag{3}$$

Recognizing that consumers' preferences may vary with various socioeconomic and demographic variables, and assuming that prices are constant in a cross-sectional data set, a consumption model for a particular nutrient can be specified as:

$$N_i = h_i(y_i, S), \tag{4}$$

where N_i corresponds to the intake of a certain nutrient by individual i; y_i corresponds to the income level of the individual i; and S is a vector representing various socioeconomic and demographic factors (Nayga and Capps).

Results of previous research provide evidence on how a number of socioeconomic and demographic variables affect food consumption behavior and nutrient intake. For example, urbanization, race, location, income, and household size have been found to significantly influence food and nutrient consumption (e.g. Buse and Salathe; Adrian and Daniel; Chavas and Keplinger).

Based on the specifications found in previous studies and conditioned by data available in the 1987–88 Nationwide Food Consumption Survey (NFCS), the exogenous variables used in the analysis include urbanization, region, race, sex, employment, ethnicity, household size, age, height, weight, and income. A dummy variable pertaining to whether the individual receives food stamps or not is also included in the analysis. The general model specification used is therefore:

$$\begin{aligned} N_{ki} = {} & b_0 + b_1\text{urban} + b_2\text{nonmetro} + b_3\text{northeast} + b_4\text{midwest} + b_5\text{west} + b_6\text{black} \\ & + b_7\text{asian} + b_8\text{other} + b_9\text{hispanic} \\ & + b_{10}\text{male} + b_{11}\text{unemployed} \\ & + b_{12}\text{fstamp} + b_{13}\text{hsize} + b_{14}\text{weight} \\ & + b_{15}\text{weightsq} + b_{16}\text{height} \\ & + b_{17}\text{heightsq} + b_{18}\text{age} + b_{19}\text{agesq} \\ & + b_{20}\text{income} + b_{21}\text{incomesq}, \end{aligned}$$

where N_{ki} refers to the average daily intake of nutrient k by individual i. Ten nutrients essential for adequate nutrition were selected for the analysis. These nutrients are food energy, protein, vitamin A, vitamin C, thiamin, riboflavin, niacin, calcium, phosphorus, and iron. The description of the variables are exhibited in Table 2.

One classification is eliminated from each group of variables for estimation purposes so as to avoid the problem of perfect multicollinearity. The base groups for each classification are individuals who satisfy the following description: reside in a sub-

Table 2. Description of the Variables Used in the Analysis

Name	Description
N_{ki}	average daily intake of nutrient k by individual i
urban	1 if individual resides in a central city; 0 otherwise
nonmetro	1 if individual resides in a nonmetro area; 0 otherwise
northeast	1 if individual is in the Northeast; 0 otherwise
midwest	1 if individual is in the Midwest; 0 otherwise
west	1 if individual is in the West; 0 otherwise
black	1 if individual is black; 0 otherwise
asian	1 if individual is Asian or Pacific Islander; 0 otherwise
other	1 if individual is of some other race; 0 otherwise
hispanic	1 if individual is hispanic; 0 otherwise
male	1 if individual is male; 0 otherwise
unemployed	1 if individual is unemployed; 0 otherwise
fstamp	1 if individual is receiving food stamps; 0 otherwise
hsize	household size
weight	weight of the individual in pounds
weightsq	square of the weight of the individual
height	height of the individual in inches
heightsq	square of the height of the individual
age	age of the individual in years
agesq	square of the age of the individual
income	household income
incomesq	square of household income

urban area; in the South; white; nonhispanic; female; employed; and not participating in the food stamp program. Household income is used instead of individual income because the NFCS data set provides income information only for the household and not for an individual. Hispanics are separated from the race variables because they are defined by USDA as an ethnic group rather than a race. Therefore, a hispanic can be white, black or some other race. Education is not included in the analysis because the NFCS data set contains information on education for only the household head. The anthropomorphic measurements of the individual—age, sex, height, and weight—are included as exogenous variables to account for physical differences between individuals. Squared terms are included for weight, height, income and age in order to investigate possible nonlinearities in the Engel relationships with the consumption of nutrients. Selected findings from the National Nutrition Monitoring and Related Research Program report have indicated some nonlinearities in the relationship between these four variables and nutrient consumption (Interagency Board for Nutrition Monitoring and Related Research).

It is hypothesized that individuals who reside in a central city or suburban area consume lesser amounts of most nutrients than individuals residing in a nonmetro area due to decreased food consumption because of more sedentary work habits (Adrian and Daniel). Urbanization is also related to several variables like accessibility to diverse types of stores providing a wide variety of foods; differences in the social, cultural, and economic environment such as occupational opportunities and education; and the amount of information available to the individual (Scearce and Jensen).

Race of the individual can affect the purchasing habits and hence the amount of nutrients available to an individual. However, race is complicated by its relationship with other socioeconomic and demographic characteristics. No a priori hypothesis is then specified about the impact of race on the amount of nutrient intake of an individual. Being male is expected to have a greater impact on nutrient intake than being female because males generally consume more food than do women (Frazao and Cleveland). Because unemployed and food stamp recipients are generally less affluent than their counterparts, they are expected to consume less amounts of various nutrients than do employed and food stamp non-recipients, respectively.

As household size increases, it is hypothesized that the individual would decrease the intake of most nutrients because of possible income constraint. As mentioned earlier, weight, height, age, and income are hypothesized to have nonlinear relationships with nutrient intake.

The analysis is based on cross-sectional data collected over the April 1987 to August 1988 period. The data set does not contain price information. Although relative prices for food items could be the same for all individuals, some urban and regional variation in the consumption of nutrients may represent urban and regional differences in average prices over the 1987–88 data collection period (Nayga and Capps). Moreover, as supply and demand conditions change over time, relative prices will change and the consumption patterns suggested in this paper could change as well.

A problem in the estimation of regression models using cross-sectional data is heteroskedasticity. When heteroskedasticity is present, ordinary least squares (OLS) estimation places more weight on the observations which have large error variances than on those with small error variances. Due to this implicit weighting, OLS parameter estimates are unbiased and consistent, but they are not efficient (Pindyck and Rubinfeld). To detect the presence of heteroskedasticity, the Breusch-Pagan-Godfrey (BPG) test is used in all the regressions (Breusch and Pagan; Godfrey). The BPG test involves an auxiliary regression in which each squared residual from the OLS estimation is regressed on the same set of regressors used in the original equation. An F-test is then performed on all the coefficients except the intercept. The null hypothesis of no heteroskedasticity is rejected if the F test is statistically significant at a specified significance level (0.05 level in this study). If heteroskedastic disturbances are indeed found in these equations, weighted least squares is employed wherein the weights are the reciprocal of the square root of the fitted values from the auxiliary regression involving the squared residuals.

Another potential problem in multiple regression analysis is multicollinearity. Multicollinearity tests are conducted in the models using the diagnostic tools described in Belsley, Kuh, and Welsch.

Data

The data set used in this study is the Individual Intake phase of the U.S. Department of Agriculture's (USDA) 1987–88 Nationwide Food Consumption Survey (NFCS). This data set is the most recent of the nationwide household food consumption surveys conducted by USDA. The individual intake phase of the 1987–88 NFCS data set provides data on three days of food intake by individuals of all ages surveyed in the 48 contiguous states. These individuals were asked to provide three consecutive days of dietary data. The first day's data were collected using 24-hour dietary recall. The time period for this one-day recall was from midnight to 11:59 p.m. on the day preceding the interview (USDA). This collection process was conducted using an in-home personal interview. Data for the second and third days were collected using a self-administered two-day dietary record.

Nutrient intake for the day is simply the sum of the amounts of nutrient in each food reported by an individual. The amount of nutrient in each food eaten was calculated using the weight (in grams) of that food and the nutritive value of that food (per 100 grams) from a nutrient data base developed by Human Nutrition Information Service (HNIS).

The number of days in which food intake information was available for an individual varied. Thus, for some individuals the information was provided for only a one-day or two-day period. Due to the different interview processes that were employed in each of the three days of intake, it is inappropriate to combine and analyze all the individuals with one day, two days, and three days of completed intake. Moreover, over 80 percent of the sample completed three days of intake. For these reasons, only individuals who completed three days of intake were included in the analysis.

The process of developing the final sample of observations for the analysis was handled in a sequential manner. The original data contains 11,045 individuals. Those individuals who do not have three days worth of intake information were dropped from the analysis. Second, those individuals who fail to report pertinent socioeconomic and demographic information were also deleted from the analysis. After the elimination of individuals with missing relevant intake and socioeconomic and demographic information, the data set contained 6,259 observations. The means and standard deviations of the variables used in the analysis are exhibited in Table 3.

Table 3. Means and Standard Deviations of the Variables Used in the Analysis, U.S., 1987–88

Variable	Mean Value	Std. Deviation
Dependent variables[a]		
Food energy (kcal.)	1732.24	682.99
Protein (gm.)	71.53	28.67
Vitamin A (i.u.)	5924.44	5778.22
Vitamin C (mg.)	88.06	65.37
Thiamin (mg.)	1.33	0.60
Riboflavin (mg.)	1.68	0.82
Niacin (mg.)	19.04	8.23
Calcium (mg.)	691.91	386.01
Phosphorus (mg.)	1099.84	458.10
Iron (mg.)	12.35	6.26
Independent variables		
Weight (lbs.)	159.44	35.31
Height (inches)	66.72	3.98
Urban	0.21	0.40
Nonmetro	0.30	0.45
Northeast	0.20	0.39
Midwest	0.27	0.44
West	0.18	0.38
Black	0.10	0.29
Asian	0.01	0.09
Other	0.03	0.10
Hispanic	0.04	0.18
Male	0.45	0.49
Unemployed	0.41	0.49
Fstamp	0.05	0.22
Hsize	3.03	1.46
Age (years)	43.29	18.40
Income ($)	29518.03	23972.90

[a]Average daily intake

Table 4. Parameter Estimates of the Nutrient Equations, U.S., 1987–88

Variable	Food Energy	Protein	Vit. A	Vit. C	Thiamin
Intercept	3987.25*	126.56*	7754.59	64.61	2.96*
	(925.17)	(39.72)	(8254.23)	(100.40)	(0.89)
Weight	1.03	0.15*	8.54	0.26	0.001
	(1.49)	(0.06)	(13.81)	(0.16)	(0.001)
Wsq	−0.001	−0.0003	−0.02	−0.0006	−0.000001
	(0.004)	(0.0002)	(0.03)	(0.0004)	(4.0E-6)
Height	−82.32*	−2.74*	−188.38	−1.05	−0.06*
	(28.01)	(1.20)	(248.55)	(3.04)	(0.02)
Hsq	0.74*	0.02*	1.78	0.01	0.0005*
	(0.21)	(0.009)	(1.88)	(0.02)	(0.0002)
Urban	−1.40	0.87	273.22	−2.78	0.001
	(20.28)	(0.87)	(196.33)	(2.20)	(0.019)
Nonmetro	17.79	1.05	−163.95	−6.71*	0.017
	(17.77)	(0.76)	(177.01)	(1.93)	(0.017)
Northeast	−15.63	0.21	677.88*	12.94*	−0.0002
	(22.16)	(0.95)	(210.23)	(2.40)	(0.02)
Midwest	−43.50*	−0.50	115.84	0.69	−0.018
	(19.58)	(0.84)	(192.28)	(2.12)	(0.018)
West	−85.47*	−2.62*	451.03*	3.52	−0.109*
	(21.64)	(0.93)	(214.09)	(2.34)	(0.02)
Black	−68.70*	−0.27	−593.68*	18.06*	−0.063*
	(25.13)	(1.08)	(266.94)	(2.73)	(0.02)
Asian	1.36	3.58	499.56	20.46*	0.13*
	(65.08)	(2.79)	(792.63)	(7.06)	(0.06)
Other	124.69*	5.20*	1042.07*	27.90*	0.13*
	(51.92)	(2.22)	(509.61)	(5.63)	(0.05)
Hispanic	−41.13	2.32	−474.26	3.86	−0.02
	(44.65)	(1.92)	(435.64)	(4.84)	(0.04)
Male	488.78*	20.33*	661.61*	9.86*	0.38*
	(22.02)	(0.94)	(210.36)	(2.39)	(0.02)
Unemployed	−5.71	0.12	310.44*	8.49*	0.02
	(17.57)	(0.75)	(173.87)	(1.91)	(0.02)
Fstamp	−28.15	−0.15	−218.60	−4.09	−0.02
	(33.58)	(1.44)	(349.46)	(3.64)	(0.03)
Hsize	2.25	−0.04	−197.70*	−3.08*	0.009*
	(5.60)	(0.24)	(56.30)	(0.61)	(0.005)
Age	−14.33*	−0.13	32.40	−0.22	−0.009*
	(2.32)	(0.10)	(22.16)	(0.25)	(0.002)
Agesq	0.10*	−0.00007	0.07	0.005*	0.0001*
	(0.02)	(0.001)	(0.23)	(0.002)	(0.00002)
Income	−0.00007	0.00002	0.02*	0.0005*	3.35E-7
	(0.0006)	(0.00002)	(0.006)	(0.00007)	(6.30E-7)
Incomesq	−2.01E-9	−8.49E-11	−4.0E-8	−1.7E-9*	−3.4E-12
	(1.0E-8)	(1.00E-10)	(4.0E-8)	(1.0E-10)	(1.0E-11)
Adj. R^2	0.24	0.20	0.04	0.05	0.14

*Statistically significant at the 0.05 level.
Note: Standard errors are in parentheses. All the equations are estimated using weighted least squares except for vitamin A.

Based on the U.S. population in 1988, the sample is underrepresentative of individuals located in the northeast and west and overrepresentative of individuals located in the south. In addition, the sample is under-representative of the number of employed individuals. The average age of individuals in the sample and the average household size are also above the national average. However, the distribution of individuals by urbanization, race, sex, and income is representative of the U.S. population in 1988 (Spencer).

Deleting data for individuals who fail to report pertinent socioeconomic and demographic information may also give rise to a potential self-selection problem. One way to assess the degree to which this problem may exist is by comparing the means of the variables used in the analysis with and without the deleted data. The means of the variables with the deleted data compare reasonably well with the means of the variables without the deleted data, except for the employment, age, and household size variables.

Table 4. Parameter Estimates of the Nutrient Equations, U.S., 1987–88 (continued)

Variable	Riboflavin	Niacin	Calcium	Phosphorus	Iron
Intercept	3.99*	31.47*	2073.67*	2776.97*	17.65*
	(1.19)	(11.62)	(557.69)	(643.56)	(9.10)
Weight	−0.0004	0.007	0.69	1.89*	−0.006
	(0.002)	(0.02)	(0.90)	(1.04)	(0.014)
Wsq	0.000003	0.000006	−0.002	−0.004	0.00003
	(0.000005)	(0.00005)	(0.002)	(0.003)	(0.00004)
Height	−0.08*	−0.60*	−45.38*	−63.21*	−0.24
	(0.03)	(0.30)	(16.89)	(19.48)	(0.27)
Hsq	0.0007*	0.005*	0.41*	0.56*	0.002
	(0.0002)	(0.002)	(0.13)	(0.15)	(0.002)
Urban	0.05*	0.14	27.52*	29.43*	0.19
	(0.02)	(0.25)	(12.23)	(14.11)	(0.20)
Nonmetro	0.03	−0.12	12.17	15.34	0.03
	(0.02)	(0.22)	(10.71)	(12.36)	(0.17)
Northeast	0.04	0.21	43.62*	13.73	−0.17
	(0.03)	(0.27)	(13.36)	(15.42)	(0.21)
Midwest	0.04	−0.27	55.70*	18.42	−0.67*
	(0.02)	(0.25)	(11.81)	(13.62)	(0.18)
West	−0.001	−1.34*	80.05*	12.15	−0.89*
	(0.03)	(0.27)	(13.04)	(15.05)	(0.21)
Black	−0.17*	−0.57*	−136.62*	−104.84*	−1.03*
	(0.03)	(0.30)	(15.15)	(17.48)	(0.24)
Asian	−0.25*	−0.49	−132.86*	−95.64*	0.13
	(0.08)	(0.82)	(39.23)	(45.27)	(0.64)
Other	0.06	1.71*	−10.75	52.98	0.87*
	(0.06)	(0.65)	(31.30)	(36.12)	(0.50)
Hispanic	−0.12*	−0.62	−99.35*	−15.74	0.19
	(0.05)	(0.56)	(26.91)	(31.06)	(0.44)
Male	0.43*	5.59*	140.67*	270.65*	3.32*
	(0.02)	(0.27)	(13.27)	(15.32)	(0.21)
Unemployed	0.05*	0.14	23.02*	12.56	0.29*
	(0.02)	(0.22)	(10.60)	(12.22)	(0.17)
Fstamp	−0.02	0.09	−36.03*	−19.13	−0.21
	(0.04)	(0.42)	(20.24)	(23.36)	(0.33)
Hsize	−0.006	−0.17*	−2.51	−3.54	−0.07
	(0.007)	(0.07)	(3.37)	(3.89)	(0.05)
Age	−0.02*	0.01	−14.14*	−10.19*	−0.06*
	(0.002)	(0.02)	(1.40)	(1.61)	(0.02)
Agesq	0.0002*	−0.0002	0.12*	0.08*	0.0007*
	(0.00003)	(0.0003)	(0.01)	(0.02)	(0.0002)
Income	5.1E-8	0.00001	0.0007*	0.0004	8.6E-6
	(8.4E-7)	(0.00001)	(0.0003)	(0.0004)	(6.4E-6)
Incomesq	−1.0E-13	−3.1E-11	−1.7E-9	−1.9E-9	−1.2E-11
	(1.0E-12)	(1.0E-10)	(1.0E-8)	(1.0E-8)	(1.0E-10)
Adj. R^2	0.12	0.17	0.13	0.18	0.11

Results

The parameter estimates of the nutrient consumption models are exhibited in Table 4. All the equations, except vitamin A's, are estimated using weighted least squares due to the presence of heteroskedastic error terms in the equations. Ordinary least squares estimation is used for the vitamin A model. Results from the collinearity diagnostic tests (Belsley, Kuh, and Welsch) conducted generally reveal no degrading multicollinearity problems in the data.[1] Due to the multiplicity and complexity of factors influencing individual food consumption, the adjusted R-squares, as expected, are relatively low. They range from 0.04 (vitamin A) to 0.24 (food energy). These values are expected, however, considering the nature (cross-section

[1] No strong dependencies among the variables were detected except between height and hsq variables. However, these variables were not deleted from the analysis because of their statistical significance in 7 of the 10 models estimated.

of individuals) of the data set used. The discussion of the results below is focused on the effects of the statistically significant variables (the 0.05 level) on average daily intake of nutrients.

Urbanization, Region, and Race

The results of the likelihood ratio tests (joint F tests) for urbanization, region, and race variables are presented in Table 5. The regional variables as a group and the race variables as a group are significant in most of the equations at the 0.05 level. In particular, the regional variables as a group contribute to the explanatory power of the nutrient equations, except in the riboflavin and phosphorus equations. Race variables as a group are significant in all the equations except in the protein equation. On the other hand, the urbanization variables as a group are significant only in the vitamin C equation.

Specifically, the empirical results indicate that individuals residing in nonmetro areas consume less of vitamin C than do individuals residing in suburban areas. This result is consistent with Adrian and Daniel's finding, using the 1965–66 NFCS, which indicates that farm households consume less vitamin C than do urban households. Windham et al., using the 1977–78 NFCS, also revealed that average consumption of vitamin C on a nutrient density basis was lower in nonmetro areas than in central city and suburban areas. Results of this study also reveal that urban individuals consume more of riboflavin, calcium, and phosphorus than do suburban individuals (Table 4).

In terms of region, individuals from the Northeast consume more vitamins A and C, and calcium than do individuals from the South. A possible reason for lower vitamin A and vitamin C intake of individuals from the South is the lower average annual consumption of fresh fruits and vegetables

Table 5. Results of the Likelihood Ratio Tests (F Values), U.S., 1987–88

Equation	Urbanization	Region	Race
Food Energy	0.62	5.74*	4.69*
Protein	1.09	3.35*	2.34
Vitamin A	2.55	4.28*	3.68*
Vitamin C	6.05*	11.15*	23.19*
Thiamin	0.57	11.00*	6.28*
Riboflavin	2.23	1.42	12.23*
Niacin	0.46	10.94*	3.66*
Calcium	2.58	14.34*	29.58*
Phosphorus	2.29	0.66	14.11*
Iron	0.52	7.84*	7.11*

*Statistically significant at the 0.05 level.

of individuals in this region compared to the Northeast (see Lutz et al., p. 36). Individuals from the Midwest consume less food energy and iron but more calcium than do individuals from the South. Individuals from the West, on the other hand, consume less food energy, protein, thiamin, niacin, and iron, but more vitamin A and calcium than do individuals from the South. The result pertaining to calcium is similar to Windham et al.'s finding using the 1977–78 NFCS. Windham et al. argued that calcium intake in the South is lower because of lower usage of milk and milk products in this region compared to other regions of the country. Indeed, using the 1987–88 NFCS, Lutz et al. (p. 34) revealed that individuals from the South consumed lower amounts of milk products on an average annual basis compared to individuals from other regions. Regional variables were not included in the analysis performed by Adrian and Daniel.

The results suggest that nutrient consumption differs by race of the individual. Blacks consume more vitamin C but less food energy, vitamin A, thiamin, riboflavin, niacin, calcium, phosphorus, and iron than do whites. In addition, Asians and Pacific Islanders consume more vitamin C and thiamin, but less riboflavin, calcium, and phosphorus than do whites. Other races consume more food energy, protein, vitamins A and C, thiamin, niacin, and iron than do whites. The reason for these results is not clear. However, the diets of Asians and Pacific Islanders contain relatively large quantities of corn and rice which lack riboflavin. Whites normally consume more meat and milk products, which are good sources of phosphorus and calcium, in their diets than do Asians and Pacific Islanders.

Similar to the result of this study, Adrian and Daniel, using the 1965–66 NFCS, revealed that black households consume less calcium than do whites. Moreover, Windham et al., using the 1977–78 NFCS, found lower calcium density in diets of non-Caucasians. There has been some evidence accumulating which indicates that a large percentage of non-Caucasian adults have high levels of lactose intolerance (Woodruff). Since milk is a major source of lactose and also of calcium, lactose intolerance may be a contributing factor to lower calcium intake among non-Caucasians. Using the 1987–88 NFCS, Lutz et al. computed the average annual household consumption of dairy products per 21-meal equivalent person by race. They reported that black households consumed around 272 pounds of dairy products compared to whites' consumption of roughly 470 pounds. Comparing these findings with previous studies using

Table 6. Simulated Impact of Weight on the Consumption of Selected Nutrients, U.S., 1987–88

	Selected Weight Levels (pounds)		
Nutrient[a]	100	150	200
Protein	67.637	71.380	73.637
Phosphorus	1027.56	1071.00	1095.56

[a]Simulated impact of weight on the consumption of the other eight nutrients are excluded because the relationship between weight and quantity consumed was not significant at the 0.05 level.
Note: These estimates were derived from the respective nutrient consumption estimates by shifting weight from each level and holding other variables other than weight at their means.

the 1965–66 and the 1977–78 NFCS data, it appears that not much progress has been made in improving the calcium intake among blacks over the period covering 1965–66 and 1987–88.

Weight, Height, and Age

Weight is significant in protein and phosphorus equations (Table 6). Consumption of protein and phosphorus increases initially and peaks, before declining with successive increments of weight, other factors held constant. These estimates are derived from the nutrient demand estimates by shifting weight from one level to another and holding other variables other than weight at their means.

Height is statistically significant in the food energy, protein, thiamin, riboflavin, niacin, calcium,

Table 7. Simulated Impact of Height on the Consumption of Selected Nutrients, U.S., 1987–88

	Selected Height Levels (inches)		
Nutrient[a]	50	60	70
Food Energy	1648.75	1639.75	1778.75
Protein	69.981	69.081	72.981
Thiamin	1.356	1.306	1.356
Riboflavin	1.974	2.011	2.182
Niacin	17.469	16.969	17.469
Calcium	803.47	800.47	879.47
Phosphorus	1047.27	1020.27	1103.27

[a]Simulated impact of height on the consumption of vitamin A, vitamin C, and iron are excluded because the relationship between height and quantity consumed was not significant at the 0.05 level.
Note: These estimates were derived from the respective nutrient consumption estimates by shifting height from each level and holding other variables other than height at their means.

Table 8. Simulated Impact of Age on the Consumption of Selected Nutrients, U.S., 1987–88

	Selected Age Levels (years)			
Nutrient[a]	20	40	60	80
Food Energy	1881.04	1714.44	1627.84	1621.24
Thiamin	1.371	1.307	1.321	1.413
Riboflavin	2.225	2.066	2.066	2.225
Calcium	835.94	781.14	878.34	1127.54
Phosphorus	1173.77	1060.17	1006.57	1012.97
Iron	10.652	10.231	10.372	11.072

[a]Simulated impact of age on the consumption of protein, vitamin A, vitamin C, and niacin are excluded because the relationship between age and quantity consumed was not significant at the 0.05 level.
Note: These estimates were derived from the respective nutrient consumption estimates by shifting age from each level and holding other variables other than age at their means.

and phosphorus models (Table 7). Consumption of these nutrients decreases initially and then increases with successive increments of height, *ceteris paribus*. The simulations reveal that consumption of food energy, protein, thiamin, and riboflavin decrease initially until height levels of 56, 57, 60, and 52 inches (inflection points) are reached. Increases in the consumption of these nutrients are then observed with successive increments of height above these levels. Similarly, the inflection points for niacin, calcium, and phosphorus consumption are 60, 55, and 57 inches, respectively.

Age is a significant factor affecting consumption of food energy, thiamin, riboflavin, calcium, phosphorus, and iron (Table 8). Consumption of these nutrients decreases initially before increasing with successive increments of age, as indicated by the significant negative and positive signs of the age and age-squared coefficients. Although not apparent in Table 8, detailed simulation values show that the inflection points where the change in direction in consumption occur is at age 72 for food energy, age 46 for thiamin, age 50 for riboflavin, age 37 for calcium, age 68 for phosphorus, and age 45 for iron.[2]

Income

Annual household income is a significant factor affecting the consumption of vitamin A, vitamin C, and calcium (Table 9). Consistent with the findings of Adrian and Daniel, consumption of these

[2] Weight, height, and age of individuals were not analyzed in the Windham et al. and Adrian and Daniel studies.

Table 9. Nutrient Income Elasticities for Selected Nutrients, U.S., 1987–88

	Selected Income Levels ($)		
Nutrient[a]	20,000	30,000	40,000
Vitamin A	0.067	0.098	0.128
Vitamin C	0.123	0.175	0.223
Calcium	0.016	0.024	0.032

[a]Elasticities for the other seven nutrients are excluded because the relationship between income and quantity consumed was not significant at the 0.05 level.

Note: Elasticities were computed with all the factors except income held at mean values and the quantity of the respective nutrient consumed allowed to vary only in response to changes in income.

nutrients increases initially, peaks, and then declines with successive increments of income. Adrian and Daniel, using consumption per household per week as dependent variables, also found income as a significant factor affecting household consumption of protein, fat, iron, and thiamin.

Empirical results indicate that nutrient responsiveness to income is small, especially at low income levels as suggested by the income elasticities presented in Table 9. In agreement with Adrian and Daniel's findings, the results suggest that nutrient responsiveness to income is small for low income individuals, which raises questions about the effectiveness of a policy aimed at generating nutritionally adequate diets through income transfers. However, similar to Adrian and Daniel's results, elasticities do indicate positive responsiveness at all selected income levels for vitamin A, vitamin C, and calcium. For an income of $20,000, the income elasticity is 0.067 with respect to vitamin A consumption, 0.123 with respect to vitamin C consumption, and 0.016 with respect to calcium consumption. Income elasticities at income levels of $30,000 and $40,000 are also computed and shown in Table 9. Income was not a significant factor affecting nutrient consumption in the Windham et al. study.

Other Variables

Males consume more of all nutrients considered in this study than do females. Results also reveal that unemployed individuals consume more vitamin A, vitamin C, riboflavin, calcium, and iron than employed individuals. The reason for this result is not clear. It may be possible that employed individuals, due to assumingly higher opportunity cost of time, have less time to eat various types of food that are good sources of these nutrients than unemployed individuals. Food stamp recipients consume relatively the same amount of all nutrients, except calcium, than do non-food stamp recipients. This result may suggest that the food stamp program is effective in helping provide nutrition to levels comparable to those of nonparticipants. Lane's finding indicates that although food stamp participants do not significantly consume less nutrients than do nonparticipants, their consumption of some nutrients would have been significantly lower without the program.

Household size is negatively related to the consumption of vitamin A, vitamin C, thiamin, and niacin. This relationship suggests that individuals in larger households are more likely to be at nutritional risk in relation to the consumption of these nutrients than individuals from smaller households. Windham et al., using the 1977–78 NFCS, also revealed a negative relationship between household size and vitamin C consumption. Using the 1965–66 NFCS, Adrian and Daniel found a positive relationship between family size and household consumption of selected nutrients. However, it is possible that some members of larger households consumed lower levels of certain nutrients even if total household food consumption has increased.

Summary and Concluding Remarks

This study investigated the effect of socioeconomic and demographic variables on nutrient intake of persons in the U.S. Results indicate that a number of socioeconomic and demographic characteristics of individuals are related to the consumption of certain nutrients. The empirical results can be summarized as follows:

(1) Region and race influence individual consumption of most food nutrients analyzed. This result implies that to be more efficient, nutrition education should not be very general in scope and should not be uniformly directed at the entire population.

(2) Height is related to the consumption of seven of the ten nutrients while age is related to the consumption of six of the ten nutrients analyzed suggesting that these factors should be considered in the design of nutrition education programs.

(3) Income affects the consumption of vitamin A, vitamin C, and calcium. Nutrient responsiveness to income is small, especially at low income levels. This relationship raises questions about the effectiveness of a policy aimed at generating nutritionally adequate diets through income transfers. Therefore, if the primary goal of the policy is to

improve the nutrition of low income persons, direct food transfers may be more effective than income transfers. Moreover, similar to the results of Windham et al., income is not a significant factor affecting the consumption of seven of the 10 nutrients analyzed suggesting that individuals with lower incomes may select good dietary quality but less costly foods to meet their dietary needs. These results also imply that future income increases have small impacts on nutrient consumption.

(4) Unemployed individuals consume more of five of the ten nutrients analyzed than do employed individuals. This relationship is probably the result of the decrease in consumption of certain foods among employed individuals due to more demanding time spent at work.

(5) Food stamp recipients do not significantly consume less of all nutrients except calcium than do non-recipients. This finding may imply that the food stamp program is an effective instrument for increasing nutrient intake of participants to levels comparable to those of nonparticipants.

(6) Individual intake of vitamin A, vitamin C, thiamin, and niacin decreases with the size of the household, implying that members of larger households are more likely to be at nutritional risk in relation to the consumption of these nutrients.

In general, some of the results in this study are similar to the results of Windham et al.'s and Adrian and Daniel's studies using the 1977–78 and the 1965–66 NFCS data sets. In particular, nutrient consumption is generally unresponsive to changes in income. Calcium intake among blacks and individuals from the South is still an area of concern. Moreover, individuals residing in nonmetro areas and the South generally consume less vitamin C than do their counterparts. Although Americans are generally more aware of the relationship between diet and health (Frazao and Cleveland), it is still not clear whether this awareness is enough to change behavior effectively. Perhaps, further study is needed to address this issue.

The various impacts of the different socio-demographic and economic factors on nutrient consumption have importance implications for nutrition education and public nutrition programs. If, in fact, people have different consumption habits, then nutrition education should not be directed at the entire population.

Although this analysis helps improve understanding of consumption of food nutrients, the results are subject to the limitations of the data used. For instance, the General Accounting Office (GAO) has expressed reservations about the representativeness of the data. Moreover, only 34 percent of the households surveyed provided individual intake data. However, the GAO concluded that it is not possible to determine if nonrespondents differed systematically from respondents. Lutz et al. (p. 13) also indicated that, in most instances, the data on food consumption were fairly consistent with the data from Continuing Consumer Expenditure Surveys.

References

Adrian, J., and R. Daniel. "Impact of Socioeconomic Factors on Consumption of Selected Food Nutrients in the United States." *American Journal of Agricultural Economics.* 58(1976):31–8.

Akin, J.D., D.K. Guilkey, and B.M. Popkin. "The School Lunch Program and Nutrient Intake: A Switching Regression Analysis." *American Journal of Agricultural Economics* 65(1983):477–85.

Basiotis, P., M. Brown, S.R. Johnson, and K.J. Morgan. "Nutrient Availability, Food Costs, and Food Stamps." *American Journal of Agricultural Economics* 65(1983):685–93.

Belsley, D.A., E. Kuh, and R.E. Welsch. *Regression Diagnostics, Identifying Influential Data and Sources of Collinearity,* Wiley, 1980.

Breusch, T.S., and A.R. Pagan. "A Simple Test for Heteroscedasticity and Random Coefficient Variation." *Econometrica* 47(1979):1287–94.

Buse, R.C., and L.E. Salathe. "Adult Equivalent Scales: An Alternative Approach." *American Journal of Agricultural Economics* 60(1978):460–8.

Capps Jr., O., and J. Schmitz. "A Recognition of Health and Nutrition Factors in Demand Analysis." *Western Journal of Agricultural Economics* 16(1991):21–35.

Chavas, J.P., and K.O. Keplinger. "Impact of Domestic Food Programs on Nutrient Intake of Low Income Persons in the United States." *Southern Journal of Agricultural Economics* 15(1983):155–63.

Davis, C.G., and P.H. Neenan. "The Impact of Food Stamps and Nutrition Education Programs on Food Groups Expenditure and Nutrient Intake of Low Income Households." *Southern Journal of Agricultural Economics* 11(1979): 121–9.

Devaney, B., and T. Fraker. "The Dietary Impacts of the School Breakfast Program." *American Journal of Agricultural Economics* 71(1989):932–48.

Devaney, B., and R. Moffitt. "Dietary Effects of the Food Stamp Program." *American Journal of Agricultural Economics* 73(1991):202–11.

Frazao, B., and L. Cleveland. "Diet-Health Awareness about Fat and Cholesterol—Only a Start." *Food Review* 17,1(1994):15–22.

Godfrey, L.G. "Testing for Multiplicative Heteroscedasticity." *Journal of Econometrics* 8(1978):227–36.

Interagency Board for Nutrition Monitoring and Related Research, *Nutrition Monitoring in the United States,* eds. B. Ervin and D. Reed, Hyattsville, Maryland, 1993.

Lane, S. "Food Distribution and Food Stamp Program Effects on Nutritional Achievement of Low Income Persons in

Kern County, California.'' *American Journal of Agricultural Economics* 60(1978):108–16.

Lutz, S.M., D.M. Smallwood, J.R. Blaylock, and M.Y. Hama. ''Changes in Food Consumption and Expenditures in American Households during the 1980s.'' U.S. Department of Agriculture Statistical Bulletin No. 849, Human Nutrition Information Service and Economic Research Service, Washington, DC, December 1992.

McCracken, V., and J. Brandt. ''Time Value and its Impact on Household Food Expenditures Away from Home.'' *Home Economics Research Journal* 18(1990):267–85.

Nayga Jr., R.M. and O. Capps. ''Analysis of Away-from-Home and At-Home Intake of Saturated Fat and Cholesterol.'' Review of Agricultural Economics 16(1994):429–40.

Pindyck, R.S., and D.L. Rubinfeld. *Econometric Models and Economic Forecasts,* Third Edition, McGraw-Hill, 1991.

Price, D.W., D.A. West, G.E. Schier, and D.Z. Price. ''Food Delivery Programs and Other Factors Affecting Nutrient Intake of Children.'' *American Journal of Agricultural Economics* 60(1978):609–18.

Scearce, W.K., and R.B. Jensen. ''Food Stamp Program Effects on Availability of Food Nutrients for Low Income Families in the Southern Region of the United States.'' *Southern Journal of Agricultural Economics* 11(1979): 113–20.

Spencer, G. ''Population Estimates and Projections: 1988–2080,'' Series P-25, No. 1018, U.S. Department of Commerce, Washington, D.C., 1989.

Windham, C., B. Wyse, R. Hansen, and R. Hurst. ''Nutrient Density of Diets in the USDA Nationwide Food Consumption Survey, 1977–78: Impact of Socioeconomic Status on Dietary Density.'' *Journal of the American Dietetic Association* 82(1983):28–34.

Woodruff, C.W. ''Milk Intolerances,'' in *Present Knowledge of Nutrition,* D.M. Hegsted, ed., 4th edition, New York, 1976.