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Nutrition Information and Household Dietary Fat Intake

Brian W. Gould and H. C. Lin

An endogenous switching regression model is used to examine how meal planner health knowledge affects dietary fat intake. Ethnicity, income, meal planner age, being on a low-fat diet, and other health awareness behaviors had significant effects on health knowledge. After controlling for differences in household and meal planner characteristics, intake of total and saturated fat was found to depend on health knowledge status.

Key words: dietary fat intake, health knowledge, switching regression.

Introduction

The 1988 report of the U.S. Surgeon General emphasized the correlation between dietary intake of saturated fat, increased blood cholesterol levels, and risk of coronary heart disease (U.S. Department of Health and Human Services 1988). That report summarized previous research which concluded that *amount* and *type* of fat intake are important predictors of blood lipid (cholesterol) levels (*Dairy Council Digest*). There is some evidence that consumers have been adjusting their diets in response to increased health knowledge and have reduced their fat intake (especially saturated fat) and cholesterol (*Dairy Council Digest*; Borra). A 1986 Food and Drug Administration (FDA) survey found that more than 60% of the respondents reported changes in eating patterns as the result of health concerns (Mueller). In a survey undertaken by the Food Marketing Institute, 64% of the respondents indicated they were very concerned with the nutrient content of their foods (*Cheese Reporter* 1992a). Thirty percent of the respondents indicated that they eat less meat and 28% eat less fats and oils than in the recent past. Putler and Frazao, in a review of previous survey research, noted that awareness of the link between coronary heart disease and fat intake increased from 8% in 1970 to 55% in 1988. Based on two food consumption surveys, mean fat intake for women between the ages of 19 and 50 fell from 41.8% of calories in 1977 to 37.3% in 1985 (Putler and Frazao).[1]

The new 1994 FDA food labeling requirements may make it easier for consumers to find nutrition information and should improve consumers' ability to adjust their diets to desired nutrient profiles (Senaur, Asp, and Kinsey). As consumers become more health conscious, many food manufacturers recognize this as an opportunity for development of new markets for products lower in fat and cholesterol. For example, in 1992, the number of new reduced fat/low cholesterol products increased 39% over 1991 introductions, with dairy products accounting for more than a third of these introductions (*Cheese Reporter* 1992b).

Previous econometric analyses of nutrient intake have been concerned with the effect of participation in government programs such as Food Stamp, National School Lunch, National School Breakfast, and nutrition education programs (Akin et al.; Butler, Ohls,

Brian W. Gould is senior scientist in the Center for Dairy Research and Department of Agricultural Economics, and H. C. Lin is a graduate research assistant in the Department of Agricultural Economics, both at the University of Wisconsin–Madison.

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and Posner; Morgan; Davis and Neenan; Devaney and Fraker; Long). Capps and Schmitz note that most of these studies showed participation in government food assistance programs led to increased nutrient intake, *ceteris paribus*. These analyses have focused on the intake of food energy and such nutrients as protein, calcium, and iron. They have not examined the impact of such programs on fat intake.

Unlike the impact of government programs, little work has been undertaken to examine how nutrition information affects food purchase decisions, the focus of the present analysis. In one of the few attempts to incorporate nutrition information into a food purchase model, Brown and Schrader developed a time-series based "cholesterol index." This index is calculated as the cumulative number of clinical articles published between 1966–87 which examine the linkage between cholesterol and heart disease. Brown and Schrader used this index in a quarterly model of shell egg demand. Capps and Schmitz applied this cholesterol index to a demand system for red meat, poultry, and fish; Yen and Chern used the same index in a model of fat and oil demand. Brown and Schrader found that egg consumption is negatively related to this index. Capps and Schmitz found significant effects of this index in determining the demand for beef, pork, and fish. Yen and Chern observed significant effects in three of nine food fats and oils considered in their model.

Jensen and Kesavan investigated the impact of awareness of the benefits of calcium intake on probability of purchase and conditional dairy product consumption. A latent variable representing consumer attitudes was found to have a positive impact on both the probability of purchasing dairy products and on consumption by women between 18 and 54 years of age.

Previous nutritional science analyses have focused on fat intake determinants. These studies, however, have tended to focus on individuals with similar socioeconomic characteristics (Hackett et al.; Reid et al.; Terry, Oakland, and Ankeny). Hackett et al. investigated dietary sources of fat among English adolescents; Reid et al. examined fat intake changes among individuals diagnosed with coronary heart disease; and Terry, Oakland, and Ankeny studied characteristics relating to the adoption of reduced total and saturated fat diets by men between 35 and 55 years of age. Given that these studies primarily are concerned with fat intake for specific groups, they overlook the impact of socioeconomic characteristics on dietary fat intake.

In the present study, we use the 1989–90 and 1990–91 U.S. Department of Agriculture (USDA) Continuing Surveys of Food Intake by Individuals and companion Diet and Health Knowledge Surveys to analyze the impact of health related information concerning the relationship on dietary fat intake. This is accomplished by estimating an econometric model which provides an analysis of factors affecting the probability of the main meal planner being aware of the link between fat intake and health status and those factors affecting dietary fat intake conditional on such awareness.

Description of the Econometric Model

In this study, we consider total and saturated fat intake by all individuals in the household. We examine the hypothesis that fat intake varies depending on main meal planner/preparer knowledge of possible health consequences of dietary fat intake. The household is assumed to maximize utility (U), which is a function of the amount of food and other goods consumed, and it is assumed that nutrient contents of foods are known (Akin et al.). We hypothesize that a household's diet/health information search activity represents an endogenous variable to the household and part of the overall nutrient intake process.

Representing health information by Ω, the household's utility maximization problem is:

$$\max_{Q_j} U = U(Q_1, \ldots, Q_F, C \mid D, \Omega) \qquad (1)$$

$$\text{s.t.} \quad Y = \sum_{j=1}^{F} P_j Q_j + C,$$

where Q_j is an $(H \times 1)$ vector of quantities of the jth commodity consumed by H households, C is an $(H \times 1)$ vector of a composite nonfood good, F is the number of food commodities, D is an $(H \times S)$ matrix of S household demographic characteristics, Y is an $(H \times 1)$ vector of household income, and P_j is the price of food j relative to the price of C, which is assumed to be one.

From (1), we obtain F demand functions:

$$(2) \qquad Q_j = Q_j(P_1, \ldots, P_F, Y \mid D, \Omega), \qquad j = 1, \ldots, F.$$

Each unit of food Q_j has $\alpha_{h,j}$ units of nutrient h. The intake of the hth nutrient is then

$$(3) \qquad N_h = \sum_{j=1}^{F} \alpha_{h,j} Q_j, \qquad h = 1, \ldots, K,$$

where N_h is an $(H \times 1)$ vector of nutrient intake and K denotes the number of nutrients.

Substituting (2) into (3), K nutrient demand equations can be represented as

$$(4) \qquad N_h = N_h(P_i, \ldots, P_F, Y \mid D, \Omega), \qquad h = 1, \ldots, K.$$

We also can use (2) and (3) to obtain the indirect utility function,

$$(5) \qquad \Gamma(P, Y) = \mathrm{Max}\{U(N_1, \ldots, N_K \mid P'Q = Y; D; \Omega)\}.$$

Similar to the formulations of Blaylock and Blisard, and of Hanemann, we use Stigler's net benefit approach to search behavior, and define latent variable I_i^* to be the net benefits of a household searching for information as to the health impacts of alternative food purchases:

$$(6) \qquad I^* = \Gamma^*(P, Y) - \Gamma(P, Y),$$

where Γ^* and Γ denote utility with and without optimal levels of search, respectively. We can relate I_i^* to a set of household characteristics,

$$(7) \qquad I^* = Z\gamma + \epsilon,$$

where Z is an $(H \times R)$ matrix of household characteristics, γ is an $(R \times 1)$ vector of parameters, ϵ is an $(H \times 1)$ error term vector, and $\epsilon \sim N(0, 1)$. I^* is not observed, but binary variable I is observable and related to I^* by

$$(8) \qquad I_i = \begin{cases} 1 & \text{if } \epsilon_i > -Z_i\gamma, \\ 0 & \text{if } \epsilon_i \leq -Z_i\gamma, \end{cases} \qquad i = 1, \ldots, H$$

(Poirier and Ruud). An example of I_i could be whether or not a household is aware of the link between saturated fat intake and coronary heart disease.

Given the above, households without information may differ in their nutrient consumption behavior from those with information. That is,

$$(9) \qquad N_h = \begin{cases} N_{1,h} & \text{if } I = 1, \\ N_{2,h} & \text{if } I = 0, \end{cases} \qquad h = 1, \ldots, K,$$

where

$$(10) \qquad N_{r,h} = X\beta_{r,h} + v_{r,h}, \qquad r = 1, 2; \quad h = 1, \ldots, K;$$

X is an $(H \times T)$ matrix of explanatory variables; $\beta_{r,h}$ is a $(T \times 1)$ vector of parameters; and $v_{r,h}$ is an $(H \times 1)$ error term vector.

The assumption that search behavior is endogenous to the household implies that N_{1i}, N_{2i}, and I_i^* are trivariate normal:

$$(11) \qquad [N_{1,h}, N_{2,h}, I^*] \sim \mathrm{N}_3(\{X_1\beta_{1,h}, X_2\beta_{2,h}, Z\gamma\}, \Sigma_h), \qquad h = 1, \ldots, K,$$

where Σ_h is the positive definite matrix,

$$(12)\qquad \Sigma_h = \begin{bmatrix} \sigma_{11,h} & \sigma_{12,h} & \sigma_{1I,h} \\ \sigma_{21,h} & \sigma_{22,h} & \sigma_{2I,h} \\ \sigma_{1I,h} & \sigma_{2I,h} & 1 \end{bmatrix}, \qquad h = 1, \ldots, K,$$

$\sigma_{mn,h}$ is the covariance of $N_{m,h}$ and $N_{n,h}$ in (11), and the $\sigma_{rI,h}$ denote the covariance between $N_{r,h}$ and I^* (Poirier and Ruud; Lee and Trost).

As noted by Akin et al., households self-select into (10) when the $\sigma_{rI,h}$ are nonzero. To observe this, we differentiate between conditional and unconditional nutrient intake. Unconditional expected nutrient intake, regardless of information status, is calculated as the sum across regimes of the probability of a household being in a particular information regime times expected nutrient intake for households in each regime:

$$(13)\qquad E(N_h) = \Phi(Z\gamma)E(N_{1,h} \mid I = 1) + (1 - \Phi(Z\gamma))E(N_{2,h} \mid I = 0),$$

where Φ is the standard normal cumulative distribution, and

$$(14)\qquad E(N_{1,h} \mid I = 1) = X_1\beta_{1,h} + \sigma_{1I,h}\left(\frac{\phi(Z\gamma)}{\Phi(Z\gamma)}\right), \qquad h = 1, \ldots, K,$$

$$(15)\qquad E(N_{2,h} \mid I = 0) = X_2\beta_{2,h} - \sigma_{2I,h}\left(\frac{\phi(Z\gamma)}{1 - \Phi(Z\gamma)}\right), \qquad h = 1, \ldots, K,$$

where ϕ is the standard normal probability density function (Poirier and Ruud; Dolton and Makepeace; Huang, Rauniker, and Misra; Lee and Brown; Kimhi). The latter terms in (14) and (15) are $E(v_r \mid I)$ and nonzero if the $\sigma_{rI,h}$ are nonzero.

The nutrient demand equations in (10) cannot be estimated using OLS procedures as the disturbance expected values of error terms are nonzero. Maddala, and Lee and Trost, note that parameter estimates can be obtained from the following likelihood function:

$$(16)\qquad L_h(\beta_{1,h}, \beta_{2,h}, \sigma_{11,h}, \sigma_{22,h}, \rho_{1,h}, \rho_{2,h})$$

$$= \prod_{i=1}^{H}\left(\frac{\left(\Phi(\mu_{1,h})\phi\left(\frac{v_{1,h}}{\sqrt{\sigma_{11,h}}}\right)\right)}{\sqrt{\sigma_{11,h}}}\right)^{I_i}\left(\frac{\left((1 - \Phi(\mu_{2,h}))\phi\left(\frac{v_{2,h}}{\sqrt{\sigma_{22,h}}}\right)\right)}{\sqrt{\sigma_{22,h}}}\right)^{(I_i-1)}, \qquad h = 1, \ldots, K,$$

where

$$(17)\qquad \mu_{j,h} = \frac{\left(Z\gamma + \frac{(\rho_{j,h}v_{j,h})}{\sqrt{\sigma_{jj,h}}}\right)}{(1 - \rho_{j,h}^2)^{1/2}}, \qquad j = 1, 2; \quad h = 1, \ldots, K,$$

$$(18)\qquad \rho_{j,h} = \frac{\sigma_{jI,h}}{\sqrt{\sigma_{jj,h}}}, \qquad h = 1, \ldots, K,$$

and ρ_j is the correlation between error terms in (7) and (10) (Lee and Trost; Poirier and Ruud). Lee and Trost note that, following Amemiya, use of this likelihood function is preferred over the two-step approach noted by Maddala in that parameter estimates are consistent and asymptotically efficient.

With expected nutrient intakes in (14) and (15), if an exogenous variable affects net benefits from search and conditional intakes, the β coefficients do not represent marginal impacts of this variable on conditional nutrient intake. That is,

$$(19)\qquad \frac{\partial E(N_{hs} \mid I = 1)}{\partial X_s} = \beta_{1s} - \gamma_s \sigma_{1I,h}\left(\frac{\phi(Z\gamma)}{\Phi(Z\gamma)}\left(Z\gamma + \frac{\phi(Z\gamma)}{\Phi(Z\gamma)}\right)\right), \quad h = 1, \ldots, K; \quad s = 1, \ldots, T,$$

$$(20)\qquad \frac{\partial E(N_{hs} \mid I = 0)}{\partial X_s} = \beta_{2s} + \gamma_s \sigma_{2I,h}\left(\frac{\phi(Z\gamma)}{(1 - \Phi(Z\gamma))}\left(Z\gamma + \frac{\phi(Z\gamma)}{(1 - \Phi(Z\gamma))}\right)\right), \quad h = 1, \ldots, K; \quad s = 1, \ldots, T$$

(Poirier and Ruud; Kimhi).

Data Description

The data used in this analysis are the USDA 1989–90 and 1990–91 Continuing Surveys of Food Intake by Individuals (CSFII) and companion Diet and Health Knowledge Surveys (DHKS).[2] The DHKS contains information on diet, health, and food safety issues for individuals identified as the main meal planner/preparer in the CSFII. The CSFII contains information on food intakes by individuals over three consecutive days. Unlike earlier versions of the CSFII, dietary information is collected for all household members. The USDA maintains a nutrient database with representative nutrient contents of approximately 6,250 food items. From this database, estimates of the intake of food energy, nutrients, and other dietary components are entered into the CSFII. In the present analysis, we focus on the intake of total and saturated fat.

Only households where all members provide three-day food intake records are used in this analysis. Similar to the studies by Adrian and Daniel; Basiotis et al.; and Scearce and Jensen, the dependent variables in our nutrient intake equations are total and saturated fat intake of all household members. We use this definition given our assumption that household (and household member) food choices will, in part, reflect the main meal planner's health knowledge awareness.[3] After omitting observations with missing values, our sample size is 2,235 households. No price data are collected in the CSFII/DHKS, and thus could not be included in the analysis.

In separate analyses of total and saturated fat intake, the dichotomous health knowledge status variables are defined by questions shown in the first two rows of table 1. Over 70% of the DHKS respondents indicated some knowledge of the relationship between fat intake and health. More than 58% recognized the relationship for saturated fat. Mean per day household intake of total and saturated fat, the dependent variables in fat intake equations, also are presented in table 1. Slightly more than a third of total fat intake is saturated fat.[4]

Identification of Exogenous Variables

Health knowledge status will be determined by the meal planner evaluating the costs of obtaining additional health related information relative to the benefits of such information. In evaluating use of alternative sources of nutrition information, Feick, Herrmann, and Warland estimate a series of probit equations, each pertaining to the use of a unique information source. Based on a survey of women between 20 and 59 years old, the authors use exogenous variables representing respondent's health status, age, marital status, presence of small children, household income, labor force participation, education, and food shopping experience in their probit equations. The authors hypothesize that the benefits from search are positively related to whether respondents are in poor health, older, married, or have small children in the household. With increased benefits, the probability of

Table 1. Description of Dichotomous Health Information Status Variables, Continuous Household Fat Intake Variables, and Fat Intake Characteristics

Variable Name	Description	Units	Mean	Std. Dev.
Dichotomous Health Status Variables:				
GENFATD	Have you heard about any health problems that might be related to how much fat a person eats?	0/1	.706	–
SATFATD	Have you heard about any health problems that might be related to how much saturated fat a person eats?	0/1	.583	–
Household Fat Intake Variables:				
FAT_CONS	Total household intake of fat	grams/day	150.3	110.0
SFAT_CONS	Total household intake of saturated fat	grams/day	54.1	42.1
Fat Intake Characteristics:				
FAT/CAPITA	Total fat intake per household member	grams/day	60.3	19.3
SFAT/CAPITA	Saturated fat intake per household member	grams/day	21.4	7.6
SFAT/FAT	Ratio of saturated fat to total fat	#	.354	.052

Source: 1989–90 and 1990–91 CSFII/DHKS (U.S. Department of Agriculture).
Note: In the estimation of the econometric model, *FAT_CONS* and *SFAT_CONS* are divided by 100.

using a particular information source will be higher. The authors also hypothesize that the costs of information search are affected primarily by the opportunity cost of time and search efficiency where opportunity cost is being determined by marginal wage rates. In their analysis, household income is used as a proxy for marginal wage rates. Search efficiency in their model is represented by education and shopping experience variables. They note that because of offsetting effects of eduction (which tends to be positively related to wage rate) and income in determining opportunity cost of time and search efficiency, the effects of these two variables on search activity may not be statistically significant.

In separate studies, Jensen and Kesavan, and Jensen, Kesavan, and Johnson develop indices of consumer knowledge of calcium intake and health, and conduct several analyses to determine factors affecting such knowledge. In these models, age of respondent, income, education, and labor force participation are used as exogenous variables.

Moorman and Matulich provide an extensive review of alternative models by which consumers undertake preventative health behavior, including obtaining nutrition information. In their review, they note that education tends to have a positive impact on health information acquisition and the undertaking of health maintenance behavior. Consistent with the observations of Feick, Herrmann, and Warland, they find the impact of respondent age on health maintenance behavior is uncertain. They also note that households with current high levels of desire to undertake preventative health behaviors are more likely to incur the costs of obtaining additional health and nutrition information. Moorman and Matulich refer to health status as being a consumer's perceived physical and mental well-being. In contrast to Feick, Herrmann, and Warland, they hypothesize a positive relationship between health status and ability to undertake additional health behaviors.

Exogenous variables used in our analysis are identified in table 2. Factors hypothesized to affect health knowledge status are meal planner age (*MP_AGE*), ethnicity (*BLACK, HISPANIC, ASIAN*), and household income (*INCOME*). Three exogenous variables are included to capture health status of the meal planner: whether that person is on a low-fat diet (*LFDIET*), on some other type of diet (*OTHDIET*), and whether the meal planner considers him/herself to be in good health (*HEALTHY*). Being located in nonrural areas (as represented by the variables *METRO* and *SUBURB*) is hypothesized to increase the availability of health services and related information and decrease the cost of obtaining such information (Adrian and Daniel).[5] As in previous research conducted by Moorman

Table 2. Means of Exogenous Variables Used in Econometric Models

Variable Name	Description	Units	Mean	Std. Dev.	Prob. (P) or Intake (I) Component	Expected Sign
Meal Planner Characteristics:						
INCOME	Total household pre-tax income	$	22,267	20,811	P, I	+, −
MP_AGE	Meal planner age	Yrs.	49.8	18.8	P	?
BLACK	Black	0/1	.123	—	P, I	?, ?
HISPANIC	Hispanic	0/1	.070	—	P, I	?, ?
ASIAN	Asian	0/1	.008	—	P, I	?, ?
HEALTHY	Meal planner has excellent or very good health	0/1	.392	—	P	+
LFDIET	Meal planner on low-fat/cholesterol diet	0/1	.090	—	P	+
OTHDIET	Meal planner on other diet	0/1	.094	—	P	+
SOMEDIET	Meal planner on some type of diet	0/1	.184	—	I	−
COMPNUT	Always compare nutrients for different brands of the same foods	0/1	.143	—	P	+
NUTRIT	Nutrition is important when purchasing food	0/1	.829	—	P	+
COLLEGE	Completed 4-year college degree	0/1	.141	—	P, I	+, −
SOMECOLL	Undertook post high school education	0/1	.177	—	P, I	+, −
NOHIGH	Did not complete high school	0/1	.322	—	P, I	−, +
Household Composition:						
*AGELT*5	No. of children <5 yrs. old	#	.221	.550	I	+
*AGE*5_10	No. of children 5–10 yrs. old	#	.257	.613	I	+
*MAGE*1117	No. of male children 11–17 yrs. old	#	.106	.366	I	+
*FAGE*1117	No. of female children 11–17 yrs. old	#	.112	.378	I	+
*MAGE*1840	No. of male household members 18–40 yrs. old	#	.334	.523	I	+
*FAGE*1840	No. of female household members 18–40 yrs. old	#	.417	.551	I	+
*MAGE*4165	No. of male household members 41–65 yrs. old	#	.258	.443	I	+
*FAGE*4165	No. of female household members 41–65 yrs. old	#	.319	.471	I	+
*MAGEOV*65	No. of male household members >65 yrs. old	#	.134	.345	I	+
*FAGEOV*65	No. of female household members >65 yrs. old	#	.243	.436	I	+
Household Location:						
METRO	Household located in central city	0/1	.306	—	P	+
SUBURB	Household located in suburb	0/1	.442	—	P	+
NE_REG	Household located in Northeast region	0/1	.053	—	P	?
MA_REG	Household located in Middle Atlantic region	0/1	.134	—	P	?
SA_REG	Household located in South Atlantic region	0/1	.197	—	P	?
WNC_REG	Household located in West North Central region	0/1	.064	—	P	?
WSC_REG	Household located in West South Central region	0/1	.096	—	P	?
ENC_REG	Household located in East North Central region	0/1	.185	—	P	?
ESC_REG	Household located in East South Central region	0/1	.072	—	P	?
MNT_REG	Household located in Mountain region	0/1	.056	—	P	?
Seasonality:						
*SEASON*2	Month of survey is between February and June	0/1	.365	—	I	?
*SEASON*3	Month of survey is July or Augsut	0/1	.160	—	I	?
*SEASON*4	Month of survey is September or October	0/1	.215	—	I	?

Source: 1989–90 and 1990–91 CSFII/DHKS (U.S. Department of Agriculture).

and Matulich, dichotomous exogenous variables *NUTRIT* and *COMPNUT* are used to represent the meal planner's propensity for undertaking other health information search activities. The role of education in obtaining health knowledge is examined by including *COLLEGE, SOMECOLL,* and *NOHIGH* in the analysis. Eight dichotomous regional variables are included to test for regional differences in health awareness probabilities not captured by the above exogenous variables.

Table 3. Summary Statistics and Hypotheses Tests

Equation Statistic/ Hypothesis Test	Type of Fat Intake: Total Fat		Saturated Fat	
Log-Likelihood Function	−2,629.8		−748.7	
Correlation Coefficients:				
Γ_h^2	.833		.816	
	Knowledge Status		Knowledge Status	
	GEN-FATD = 1	*GEN-FATD* = 0	*SAT-FATD* = 1	*SAT-FATD* = 0
$\Gamma_{r,h}^2$	.846	.818	.828	.809
χ^2 (d.f.) for H_0: $\rho_{1,h} = \rho_{2,h} = 0$	33.2 (2)*		29.9 (2)*	
χ^2 (d.f.) for H_0: $\beta_{1,h} = \beta_{2,h}$, $\rho_{1,h} = \rho_{2,h} = 0$	58.3 (22)*		35.5 (22)*	

Note: The asterisks (*) indicate significance at the .05 level.

As noted earlier, previous nutritional-science based analyses of dietary fat intake determinants have focused either on a small population of survey respondents or have not controlled for differing socioeconomic characteristics (Shepherd; Towler and Shepherd). In a review of previous economic models of nutrient intake, we identified likely exogenous variables to include in our fat intake equations. First, given our analysis is based on total household intake, age/sex composition of household members must be a key determinant (Adrian and Daniel). For example, dietary fat is an important source of food energy whose recommended intake levels are dependent on an individual's age, sex, pregnancy status, weight, height, and physical activity (National Research Council).[6] Basiotis et al. use six variables representing number of household members in various age/sex groupings. Here we use 10 age/sex count variables in the fat intake component of the model.

Adrian and Daniel investigated total household nutrient intake using the 1965–66 USDA Nationwide Food Consumption Survey. Their study is one of the few in which the relationships between fat intake and socioeconomic characteristics are directly examined. Exogenous variables included in their analysis were income, education of the female head, ethnicity, urban/rural location, household size, and several variables representing developmental "stages" of the family. Findings included a positive (but declining) income effect on fat intake, nonwhite households consume less fat, college graduates consume less fat, and a household's life cycle is an important determinant.

Devaney and Fraker examined nutrient intake impacts of participation in the national School Breakfast Program. Besides participation in the above program, variables found to affect nutrient intake include ethnicity, education of the female head, region of residence, household income, household size, and age of the respondent. In their analysis of cholesterol intake, they found that, depending on child group analyzed, cholesterol intake was greater for Black and Hispanic children, and positively related to child age. In an analysis of the effect of federal transfer programs on elderly nutrient intake, Akin et al. found income, ethnicity, education, health status, and age significant determinants. In a review of previous research, Morgan noted that income, food assistance, age/sex composition of household members, nutrition information, education, regional location, and ethnicity are typical exogenous variables in econometric models of nutrient intake.

Besides age/sex count variables, other exogenous variables included in the fat intake component of our model are household income, ethnicity of the main meal planner, seasonal dummy variables, education of the meal planner, and a dichotomous variable identifying whether the meal planner is following some type of diet.[7]

Estimation

Two applications of the endogenous switching model are estimated, one for total and one for saturated fat. In our analysis of total fat intake, the dichotomous variable used to represent health knowledge status is *GENFATD* and the fat intake variable is *FAT_CONS*. For our saturated fat analysis, the dependent variables are *SATFATD* and *SFAT_CONS*.[8] Parameter estimates are obtained from the maximization of the logarithm of the likelihood function shown in (16).[9] We evaluate the overall fit of the econometric models by estimating squared correlation coefficients of predicted and actual conditional and unconditional fat intake (table 3). Conditional expected intake levels are obtained using (14) and (15), while expected fat intake is calculated using (13). For both fat types, squared correlation coefficients are greater than .8. We test the hypothesis that fat intake is independent of health knowledge status (e.g., $\rho_{j,h} = 0$). Using a likelihood ratio test, this null hypothesis is rejected for both fat types. We also test the hypothesis of equal slope parameters across knowledge regime given independent intake equations. The resulting χ^2 statistics imply rejection of this hypothesis for both total and saturated fat intake (table 3).

Factors Affecting Health Knowledge Status

Parameter estimates associated with explaining meal planner health knowledge status are shown in table 4. With the dichotomous exogenous variables used in this portion of the model, the base household is one located in a rural area where the main meal planner is not on a diet, does not describe his/her diet as being very good, and does not use package label nutrient information on a regular basis. Supporting the hypothesis of Feick, Herrmann, and Warland, and of Moorman and Matulich, the meal planner being on a low fat/cholesterol diet (*LFDIET*) is positively correlated with the probability of being aware of the health implications of dietary fat intake. Having self-perceived good health is positively correlated with health knowledge, supporting the argument of Moorman and Matulich that good health enables an individual to undertake additional health behaviors. As hypothesized, positive *COMPNUT* and *NUTRIT* coefficients show the importance of other health behavior on undertaking health related activities.

Location of residence (*METRO, SUBURB*) has little impact on meal planner awareness. As noted above, meal planner's age is used as an exogenous variable in order to examine knowledge status across age cohorts, with the net impact of age being uncertain. For older meal planners, there may be more illness, making them more sensitive to diet and health (Feick, Herrmann, and Warland). Similarly, Grossman notes that when using respondent age as a proxy for health capital, the stock of such capital depreciates with age, implying greater search for health related information. Alternatively, younger meal planners have gown up in an era where health information is more readily available than did older respondents (e.g., lower search costs). The insignificant meal planner age coefficients reinforce these conflicting age cohort effects and support the review of Moorman and Matulich.

There is a differential impact of ethnicity on knowledge status. Black and Hispanic households have a lower probability of being aware of the effects of saturated fat intake when compared to non-minority households. Little evidence exists for such an effect for total fat intake. Household income has a positive impact on health knowledge status. This appears to contradict the hypothesis that higher marginal wage rates (as represented by household income) generate higher opportunity costs of time, which reduce search activity. One explanation for the positive income effects is the correlation between income and education, where the positive income effects may be reflecting improved search efficiency for more educated meal planners (Feick, Herrmann, and Warland). Also, with greater levels of income, the household may be better able to incur search costs than lower income households.

Nine dichotomous regional exogenous variables are used in this component of the

Table 4. Parameter Estimates Affecting Probability of Health Knowledge

Variable	Total Fat/Health Problem		Saturated Fat/Health Problem	
	Estimated Coefficient	Standard Error	Estimated Coefficient	Standard Error
INTERCEPT	−.146	.296	.042	.293
Meal Planner Characteristics:				
LFDIET	.325*	.106	.391*	.100
OTHDIET	.013	.097	−.027	.093
COMPNUT	.163*	.077	.188*	.071
NUTRIT	.201*	.071	.171*	.070
METRO	.078	.070	.015	.071
SUBURB	.113	.068	−.004	.068
HEALTHY	.161*	.055	.108*	.053
ln(*MP_AGE*)	.107	.073	.014	.073
ln(*INCOME*)	.260*	.043	.163*	.042
BLACK	−.131	.092	−.287*	.092
HISPANIC	.001	.113	−.214*	.107
ASIAN	−.263	.297	−.244	.289
COLLEGE	.360*	.109	.489*	.100
SOMECOLL	.213*	.087	.136	.081
NOHIGH	−.017	.073	−.148*	.071
Region of Residence:				
NE_REG	−.355*	.129	−.080	.142
MA_REG	−.228*	.105	−.240*	.097
SA_REG	−.233*	.096	−.224*	.088
WNC_REG	−.112	.118	−.098	.118
WSC_REG	−.345*	.112	−.355*	.107
ENC_REG	−.302*	.094	−.248*	.089
ESC_REG	−.221	.125	−.102	.117
MNT_REG	−.407*	.127	−.138	.128

Note: The asterisks (*) indicate significance at the .05 level.

econometric model. Households in the Pacific region are the base households and, in general, tend to be more knowledgeable of the implications of dietary fat (e.g., all regional variable coefficients are negative).

From parameter estimates in table 4, we simulate meal planner health awareness probabilities for a variety of households (table 5). If the meal planner is on a reduced-fat diet, we estimate awareness probabilities of 80.7% and 69.6% for total and saturated fat, respectively. If a meal planner is not on any diet, the simulated probability decreases to 70.6% for total and 57.7% for saturated fat. If the meal planner is not on some type of diet and does not consider nutrient contents when purchasing food, awareness probabilities are 61.4% for total and 49.3% for saturated fat. In terms of the effect of changes in income, there is greater than a 10 percentage point increase in awareness probabilities for households with pre-tax incomes of $80,000 compared to those with incomes of $15,000.

Factors Affecting Total and Saturated Fat Intake

Conditional fat intake parameter estimates are shown in table 6. Similar to the impact on awareness probability, household income has a significant impact on fat intake. In comparison, Adrian and Daniel found a positive but declining income effect on household fat intake. Basiotis et al. observed significant positive income effects on total household food energy intake. In contrast, Devaney and Fraker, in their analysis of children's energy and cholesterol intake, found that per capita household income has no effect. We find a

Table 5. Simulated Probability of Meal Planner Being Knowledgeable of Health Implications of Dietary Fat Intake

Simulation Scenario	Total Fat	Saturated Fat
Evaluated at Sample Means:	.716	.587
Healthy Diet/Informed Shopper:		
COMPNUT = *NUTRIT* = *HEALTHY* = *LFDIET* = *OTHDIET* = 0	.614	.493
LFDIET = *OTHDIET* = 0	.706	.577
LFDIET = 1; *OTHDIET* = 0	.807	.696
COMPNUT = *NUTRIT* = 1	.773	.660
Household Income:		
INCOME = $15,000	.713	.585
INCOME = $40,000	.793	.646
INCOME = $80,000	.841	.687
Ethnicity of Meal Planner:		
BLACK = 1; *HISPANIC* = 0	.678	.494
HISPANIC = 1; *BLACK* = 0	.723	.523
BLACK = 0; *HISPANIC* = 0	.723	.607
Education of Meal Planner:		
COLLEGE = 1; *SOMECOLL* = *NOHIGH* = 0	.803	.746
SOMECOLL = 1; *COLLEGE* = *NOHIGH* = 0	.759	.622
NOHIGH = 1; *COLLEGE* = *SOMECOLL* = 0	.682	.511
Region of Residence:		
MA_REG = 1	.718	.564
SA_REG = 1	.716	.571
WSC_REG = 1	.677	.518
ENC_REG = 1	.692	.561
PAC_REG = 1	.789	.656

Note: For each scenario, all variables are set at their mean values except for the variables indicated in the first column.

positive relationship between *COLLEGE* and fat intake for households with health knowledge. These results may be reflecting the positive income effects on intake.

In contrast to the results obtained in terms of factors affecting health knowledge status, ethnicity plays an important part in determining a household's total and saturated fat intake. Regardless of knowledge status, Asian households have lower fat intakes. Black households with health knowledge exhibit different fat intake patterns than non-minority households, in contrast to Black households without such information. Adrian and Daniel found, when comparing Asian and Black households, that there is no significant difference in fat intake, *ceteris paribus*. They did find significant differences for other minorities. Basiotis et al., in their analysis of food energy intake, found non-Black minority households had lower intakes. In their analysis of elderly nutrient intake, Butler, Ohls, and Posner observed, after controlling for differences in other household characteristics, that Black respondents have lower energy intake than non-Black individuals. Akin et al. found no difference in caloric intake between white and nonwhite elderly individuals. For children between the ages of five and 10, Devaney and Fraker found Black and Hispanic children to intake significantly more cholesterol than white children; however, they did not find such a relationship for children between 11 and 21 years of age.

As expected, number of household members positively impacts total household intake of total and saturated fat. The smallest total fat marginal impact of changes in household composition is for the addition of a child less than five years of age, while the largest marginal impact is for a male between the ages of 18 and 40. For saturated fat, female

Table 6. Conditional Total and Saturated Fat Intake Parameter Estimates

	Type of Fat Intake			
	Total Fat		Saturated Fat	
Variable	*GENFATD* = 1	*GENFATD* = 0	*SATFATD* = 1	*SATFATD* = 0
INTERCEPT	−.237*	.275*	−.120*	.039
	(.045)	(.108)	(.021)	(.057)
Meal Planner Characteristics:				
ln(*INCOME*)	.067*	.168*	.023*	.039*
	(.021)	(.040)	(.010)	(.013)
BLACK	−.120*	.079	−.070*	−.016
	(.045)	(.056)	(.022)	(.023)
HISPANIC	−.084	−.129	−.054*	−.070*
	(.049)	(.068)	(.023)	(.021)
ASIAN	−.390*	−.587*	−.145*	−.216*
	(.135)	(.143)	(.058)	(.072)
SOMEDIET	−.069*	−.018	−.030*	−.026
	(.033)	(.064)	(.015)	(.021)
COLLEGE	.086*	−.002	.046*	−.020
	(.042)	(.088)	(.018)	(.041)
SOMECOLL	−.028	.045	−.003	−.009
	(.037)	(.065)	(.016)	(.020)
NOHIGH	−.029	.030	−.017	−.002
	(.034)	(.047)	(.017)	(.017)
Household Composition:				
*AGELT*5	.496*	.476*	.205*	.200*
	(.018)	(.032)	(.008)	(.009)
*AGE*5_10	.672*	.673*	.251*	.264*
	(.015)	(.030)	(.007)	(.010)
*MAGE*1117	.743*	.614*	.286*	.267*
	(.020)	(.042)	(.009)	(.010)
*FAGE*1117	.654*	.589*	.241*	.225*
	(.021)	(.039)	(.011)	(.011)
*MAGE*1840	.836*	.721*	.304*	.260*
	(.025)	(.041)	(.012)	(.013)
*FAGE*1840	.582*	.539*	.199*	.195*
	(.023)	(.039)	(.013)	(.008)
*MAGE*4165	.729*	.665*	.249*	.236*
	(.033)	(.058)	(.015)	(.019)
*FAGE*4165	.591*	.563*	.195*	.186*
	(.030)	(.058)	(.015)	(.017)
*MAGEOV*65	.661*	.531*	.216*	.194*
	(.049)	(.083)	(.022)	(.031)
*FAGEOV*65	.591*	.483*	.206*	.154*
	(.048)	(.060)	(.022)	(.024)
Seasonality:				
*SEASON*2	.034	.118*	.013	.034*
	(.031)	(.050)	(.014)	(.017)
*SEASON*3	−.020	.132*	−.016	.025
	(.038)	(.061)	(.017)	(.021)
*SEASON*4	−.010	.005	−.013	−.008
	(.034)	(.060)	(.015)	(.020)
Error Variances/Correlation Coefficients:				
σ_{jj}	.269*	.268*	.048*	.035*
	(.016)	(.043)	(.003)	(.003)
ρ_j	.747*	.585*	.788*	.147
	(.047)	(.140)	(.037)	(.339)

Notes: The asterisks (*) indicate significance at the .05 level; σ_{jj} is the variance of conditional intake equation error terms and is defined in equation (12); ρ_j is the correlation coefficient between probit and conditional nutrient intake error terms and is defined by equations (12) and (20).

Table 7. Simulated Conditional Household Fat Intakes by Health Knowledge Status and Household Type

	Total Fat Intake (grams/day)			Saturated Fat Intake (grams/day)		
Household Type	*GEN-FATD* = 1	*GEN-FATD* = 0	Ratio	*SAT-FATD* = 1	*SAT-FATD* = 0	Ratio
Evaluated at Sample Means:	137.0	173.5	.79	45.0	55.7	.81
General Household Types:						
Black household	106.9	177.3	.60	32.3	52.7	.61
Hispanic household	148.7	205.3	.72	46.6	64.5	.72
Asian household	159.0	214.6	.74	54.8	66.0	.83
White household	139.7	169.0	.83	46.1	55.3	.83
Meal planner completed college	152.6	178.5	.85	52.5	53.4	.98
Meal planner high school graduate	145.8	190.7	.76	48.1	62.0	.78
Meal planner less than high school	106.4	156.2	.68	32.5	47.9	.68
Effect of Household Composition:						
Two-person household, 2 adults, 18–40 yrs.	126.5	167.8	.75	41.2	51.8	.80
Two-person household, 2 adults, 41–65 yrs.	114.9	163.0	.70	34.7	47.9	.72
Two-person household, 2 adults, 66+ yrs.	103.8	137.5	.75	30.8	39.8	.77
Regional Impacts:						
Household in Pacific region	125.4	142.5	.88	39.3	48.6	.81
Household in West South Central region	140.4	166.3	.84	45.4	54.1	.84
Household in East North Central region	160.7	175.2	.92	51.3	62.9	.82
Household in Northeast region	163.8	216.8	.76	53.9	75.2	.72
Two-Person Household, Adults 41-65 Years Old:						
Black household	98.5	156.7	.63	26.4	43.0	.61
Hispanic household	100.7	157.9	.64	27.9	40.7	.69
White household	117.6	164.2	.72	35.9	49.6	.72
Meal planner completed college	126.9	185.6	.68	40.5	49.7	.81
Meal planner high school graduate	115.4	160.3	.72	34.5	48.7	.71
Meal planner less than high school	107.1	161.9	.66	30.9	46.5	.66

Note: Expected intakes are evaluated at sample means of exogenous variables for each household type.

adults over 40 generate the smallest marginal fat intake impacts. Not surprisingly, for both fat types, male household members have higher intakes than female members.

In table 7, we show the results of simulating expected conditional fat intake for several household types using equations (14) and (15). The effect of health information on fat intake is shown by the ratio of expected intakes across knowledge status. We find that across fat type, intake ratios are similar. Health knowledge has the most significant effect on total fat intake for Black households, with a ratio value of .60. Health knowledge has little impact on fat intake for households where the meal planner has completed college. This is not surprising, as these individuals are more likely to be concerned with health and to be better able to incorporate health information into food purchase decisions. We control for effects of household composition by examining expected nutrient intake for two-adult households with the adults between 41 and 65 years of age (i.e., last six rows of table 7). Black and Hispanic households consume less total and saturated fat under both health knowledge regimes than non-minority households, probably reflecting differences in household income.

The effect of income on awareness probability and conditional fat intake is shown in table 8. Changes in income generate relatively inelastic responses. Basiotis et al. generated income-nutrient elasticities. For all nutrients included in their analysis, these income elasticities are relatively elastic. For example, for food energy intake the range is from .08 to .12, depending on income level. Adrian and Daniel estimated a series of income elasticities at a variety of income levels. The range of elasticities was from .049 to .142, depending on income level. A similar range of elasticity values was obtained here. In

Table 8. Income Elasticities for Various Household Types.

Household Type	Income Elasticity Effect on: Health Knowledge Probability: Total Fat	Health Knowledge Probability: Saturated Fat	Household Fat Intake: Total Fat: *GENFATD* = 1	Total Fat: *GENFATD* = 0	Saturated Fat: *SATFATD* = 1	Saturated Fat: *SATFATD* = 0
Evaluated at sample means	.123	.108	.045	.094	.047	.069
Black household	.169	.153	.057	.092	.065	.074
Hispanic household	.134	.136	.042	.079	.045	.060
Asian household	.119	.100	.039	.076	.039	.059
White household	.115	.100	.045	.096	.047	.070
Meal planner completed college	.066	.057	.042	.090	.042	.072
Meal planner high school graduate	.113	.102	.054	.101	.040	.062
Meal planner less than high school	.158	.142	.058	.104	.065	.081
Two-person household, 2 adults, 18–40 yrs.	.111	.095	.049	.097	.052	.075
Two-person household, 2 adults, 41–65 yrs.	.094	.092	.055	.099	.062	.081
Two-person household, 2 adults, 66+ yrs.	.106	.101	.060	.118	.070	.097
Household in Pacific region	.087	.087	.050	.114	.054	.080
Household in West South Central region	.150	.136	.044	.098	.047	.072
Household in East North Central region	.135	.113	.039	.093	.042	.062
Household in Northeast region	.119	.087	.038	.075	.040	.051

Note: Elasticities are calculated using means of exogenous and predicted conditional intakes for each household type.

terms of the effect of changes in income on health knowledge probability, income elasticity values are similar across fat type. For example, over the entire sample, estimated income elasticities of .123 to .108 for total and saturated fat, respectively, were obtained. These compare to elasticities of .066 and .057, respectively, for households where the meal planner has completed college. Health knowledge reduces the effect of income on fat intake. For each fat type, estimated income elasticities are less for households aware of the effects of fat intake, compared to those without this information.

Conclusions

The primary objective of this research was to determine if nutrition information affects dietary fat intake. In this analysis, we used the USDA Continuing Surveys of Food Intake by Individuals and associated Diet and Health Knowledge Surveys. An endogenous switching regression model was used to partition our sample households into two regimes depending on the level of awareness of possible health consequences of dietary fat intake. The model provides statistically significant explanatory power shown by relatively large correlation coefficients of predicted and actual fat intakes. We reject the hypotheses that behavioral equations defining fat intake do not differ according to health information status and that intake is independent of information search activity.

We find that health awareness probability is positively related to household income. Use of nutrition label information in making food purchase decisions is a significant signal that the meal planner is aware of the implications of dietary fat intake. Other important variables affecting health awareness are meal planner age, and whether the meal planner is on some type of diet. A variety of household characteristics were found to affect conditional fat intake, including household income, sex/age composition of household members, and ethnicity.

Our analysis identified target populations where benefits of health knowledge are not known and where public health resources may need to be allocated to promote undertaking of health awareness activities. Not surprisingly, minority households with lower education levels are primary target populations. Our results show that, similar to the conclusions of Moorman and Matulich, health motivation shown by consumers in one area carries over to other health related activities. Thus nutrition information programs may want to broad base with a multitude of nutritional messages, as there is a positive correlation with undertaking health related activities.

We find that health knowledge status significantly impacts total and saturated fat intake. These results have important public policy implications in that if the perceived benefits of the adoption of more healthy diets (e.g., less likely to experience coronary heart disease) can be made better known, this will be translated into more desirable food purchase decisions (e.g., reduced fat intake).

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Notes

[1] Current dietary guidelines suggest that less than 30% of calories should originate from dietary fat and 10% from saturated fat (U.S. Senate; American Heart Association; U.S. Department of Agriculture 1990; U.S. Department of Health and Human Services 1990). Senaur, Asp, and Kinsey provide a review of previous analyses of consumer response to nutrition information.

[2] Investigating whether there are differences in the role of health knowledge across survey years would have increased manuscript length. We examined conditional means of fat intake, health knowledge, and household characteristics, and found little difference across survey years. Since testing of stationary preferences is not the focus of the present analysis, we merged data from 1989–90 and 1990–91.

[3] In the CSFII, the main meal planner is defined as the person most responsible for planning and preparing household meals.

[4] One reviewer raised the possibility that persons with knowledge of the health implications of dietary fat intake may under-report the consumption of foods with high fat contents and would bias our results. We could not examine this issue, given data available in the CSFII. Other than previous versions of the CSFII and the National Health and Nutrition Examination Surveys, there is little information available to verify the reasonableness of fat intake data reported in the CSFII.

[5] The variable *METRO* is set equal to 1 if a household is located in one of the Office of Management and Budget's designated central cities in a Metropolitan Statistical Area (MSA). The variable *SUBURB* is set equal to 1 if a household is located in an MSA but not a central city.

[6] Recommended energy intake for children between one and three years of age is 1,300 kcal/day, 2,300 kcal/day for males greater than 51 years old, and 1,900 kcal/day for females of the same age (National Research Council, p. 33).

[7] The low mean income level is due to the large sample of low-income households included in the CSFII. Of the 2,235 households in the sample, more than 31% are classified as low income.

[8] To facilitate estimation of the econometric model, we divided fat intakes by 100.

[9] As suggested by Lee and Trost, we obtained initial starting values for maximum likelihood estimation using the two-stage method proposed by Maddala.

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