Consumer Knowledge, Food Label Use and Grain Consumption

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Responding to mounting evidence of the association between whole-grain consumption and a reduced risk of heart problems and other diseases as well as body weight maintenance, the U.S. Government has strongly encouraged its citizens to increase consumption of whole grains. However, compared against the 2005 Federal dietary recommendations, in 1994-96 only 6 percent of Americans met the current recommended whole-grain consumption. To narrow this huge gap between actual and recommended consumption of whole grains, an effective nutrition education campaign is needed. A demand system with two censored consumption equations and two endogenous knowledge and attitude variables is estimated to investigate the factors that affect the consumption of whole and refined grains. The results can be used to help develop an effective education campaign in promoting consumption of whole grains in Americans' diets.

Key words: censored dependent variables; grain consumption; simultaneous equation system.

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As a staple food in American diet, grain products are available to consumers in two basic forms — refined and whole grains, both of which can be enriched. Compared to refined grains, whole grains provide greater amounts of vitamin, minerals, fiber, and other protective substances. Despite these nutritional advantages, Americans tend to favor the consumption of refined grains over whole grains.

Responding to mounting evidence of the association between whole-grain consumption and a reduced risk of heart problems and other diseases as well as body weight maintenance, the U.S. Government has been promoting consumption of grains, especially whole grains, in American diet. The *Healthy People 2010* aims at increasing the proportion of persons consuming at least 6 daily servings of grain products, with at least 3 servings of whole grains (USDHHS). Data from the most recent USDA's food consumption survey indicate that only half of Americans consumed 6 or more servings of grain products a day, and only 1 in 10 consumers consumed 3 or more servings of whole-grain products a day during 1994-96 (Kantor et al.).

The 2005 *Dietary Guidelines for Americans* makes several changes in the recommendations for grain consumption (USDA and USDHHS). First, the recommendations for total grains have been revised downward. For example, the recommended total grain consumption is now 5 ounce-equivalent (servings) instead of 6 for a 1600-calorie diet. Second, at least half of total grains consumed should come from whole grains. Third, the new guidelines cover a much wider range of food energy intakes from 1,000 to 3,100 calories, compared to the 1,600-2,800 calories specified in the previous guidelines. Under these new guidelines, the average American age 2 and up consumed slightly more than the recommended total grains (103 percent), using data from the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII) conducted by USDA's Agricultural Research Service (ARS). Americans over-consumed refined grains averaging 75 percent over the recommendation. It is a major challenge for Americans to meet the new guidelines on whole grains, as the 1994-96 consumption amounted to 31 percent of the recommended level and only 6 percent of consumers met the recommendation.

The grain industry and the public health community share an interest in increasing whole-grain consumption, with marketing and public health campaigns aiming at promoting such consumption. Designing effective promotional or marketing strategies require a good knowledge of grain consumption patterns. What are the factors associated with low or high consumption of grains and whole grains? Which population subgroups are particularly deficient in meeting the recommendation? Currently, such information is very limited (Harnack, Walters, and Jacobs; Kantor et al.; Moutou, Brewster, and Fox).

One of the objectives of this study is to conduct a regression analysis to identify social, economic, demographic, knowledge, and behavioral factors that are associated with consumption of whole-grain products. Heterogeneity of preference has traditionally played a role in consumer demand and the roles of socio-demographic factors are often investigated in empirical studies. Other factors considered in the empirical literature include consumer knowledge and behavior. The literature on the effects of dietary knowledge and food-label use on food and nutrient intake and diet quality has proliferated since the release of the 1994-96 Dietary and Health Knowledge Survey and the passage of the 1990 Nutritional Label and Education Act (NLEA). Dietary knowledge has been linked to food consumption, including fat-modified foods (Coleman and Wilson), egg (Brown and Schrader; Kan and Yen; Yen, Jensen, and Wang), meat (Kaabia, Angulo, and Gil; Kinnucan et al.), and 25 food groups consumed at and away from home (Lin et al.). Dietary knowledge has also been linked to the diet quality of children (Variyam et al. 1999), elderly (Howard et al.), and female household heads (Ramezani and Roeder). With respect to nutrient intake, there are reported links between knowledge and intake of fat (Carlson and Gould), fiber (Variyam, Blaylock, and Smallwood 1996), energy and nutrient density (Bhargava), and fat and cholesterol (Variyam, Blaylock, and Smallwood 1997, 1999). The use of nutrition fact panel mandated under NLEA has been found to affect the intake of fat (Kreuter and Brennan; Neuhouser, Kristal, and Patterson) and fats, cholesterol, sodium, and fiber (Kim, Nayga, and Capps).

Unlike socio-demographic factors, consumer knowledge and behavior are likely to be also determined by the factors that determine consumption; that is, they are likely to be endogenous. In this study, we investigate the roles of consumer knowledge and food-label use (as a knowledge-promoting device) as well as socio-demographic factors in the consumption of grain products, using data from a national food consumption survey in the United States.

As in other empirical analyses based on survey data, the sample we use contains a notable proportion of observations not consuming whole grains. This is the issue of censored dependent variable. In addition, as stated, consumer knowledge and food label use are potentially endogenous. It is well known that statistical procedures not accommodating censoring or endogeneity produce biased estimates. To accommodate these data features we construct a system of censored equations with dual endogenous regressors. Such an econometric specification has not been reported in the literature.

Data

The USDA has conducted periodic food consumption surveys in the United States since the 1930's. The most recent food consumption surveys, the 1994-96 Continuing Survey of Food Intakes by Individuals (CSFII 1994-96) and its companion Diet and Health Knowledge Survey (DHKS), conducted by USDA, provide the data for this study (USDA-ARS). The CSFII is the only national survey that includes a comprehensive section on dietary and health knowledge and attitudes. Each year of the 1994-96 CSFII survey comprises a nationally-representative sample of non-institutionalized persons residing in the United States.

In the CSFII, two nonconsecutive days of dietary data for individuals of all ages were collected three to ten days apart through in-person interviews using 24-hour recalls. The 1994-96 CSFII data provide information on the food intakes of 15,303 individuals, who provided a list of food items and their amounts consumed. After the respondents reported their first day of dietary intake, an adult 20 years old or above was randomly selected from each household to participate in the DHKS. The DHKS questions cover a wide range of issues, including self-perceptions of the adequacy of nutrient intakes, awareness of diet-health relationships, knowledge of dietary recommendations, perceived importance of following dietary guidance, use and perceptions of food labels, and behaviors related to fat intake and food safety. Out of 7,842 households eligible to participate in the DHKS, respondents from 5,765 households completed the survey.

The ARS created several technical databases, including a Pyramid Servings Database (PSD), to support use of CSFII data. The PSD converts the amount of food consumed into the number of servings for comparison with dietary recommendations in the 1995 and 2000 *Dietary Guidelines for Americans*. The PSD shows, for each food consumed, the number of servings from 30 food groups, including refined and whole grains. However, in the 2005 *Dietary Guidelines*, recommendations on food consumption are expressed in cups (for fruits, vegetables, and dairy products) and ounce-equivalents (grains and meat) instead of servings. This does not affect the measurement of grain consumption because one ounce-equivalent is identical to one serving for grain products. Therefore, the PSD is still directly applicable to the current recommendation on grain consumption.

Socioeconomic and demographic data for the sample households and their members are also reported in the CSFII. The explanatory variables for grain consumption (refined and whole grains separately) include household income, household size, household structure, gender, age, race/ethnicity, location, and season (see table 1 for variable definitions and sample statistics). We hypothesize that the use of nutrition label and the perceived importance of consuming plenty of grain products also affect grain consumption, and these two variables are endogenized in a system of 4 equations. In addition to income, gender, age, and race/ethnicity, the use of nutrition label and perceived importance of grain consumption are hypothesized to be affected by education, exercise, smoking, whether the respondent is a meal planner, whether anyone in the household is on a special diet, and whether the respondent subscribes to the notion that some people are born to be fat. Many of these variables and the use of label and the perceived importance come from the DHKS, hence our analysis is limited to the CSFII adult sample.

Excluding those observations with missing values, there are 5,501 adults included in the final sample. Of the sample, 72.8% consumed whole-grain products, while almost all individuals (99.8%) consumed refined-grain products.

In the DHKS, respondents were asked when they buy foods, do they often, sometimes, rarely, or never use the information on: (1) the list of ingredients, (2) the short phrases on the label like “low fat” or “light” or “good source of fiber”, (3) the nutrition panel listing the amount of nutrients, and (4) claims on health benefits of nutrients or foods. These four possible answers are grouped into use (often or sometimes) and not use (rarely or never). The DHKS respondents were also asked about their perceived importance (very, somewhat, not too, or not at all important) in choosing a diet with plenty of breads, cereals, rice, and pasta. The answers were grouped into important (very or somewhat) and not important (not too or not at all).

Econometric Model

We develop an estimation procedure for an equation system with censored dependent variables and endogenous regressors. In what follows observation subscripts are suppressed for brevity. Two binary endogenous regressors, food label use (y_1) and nutrition knowledge (y_2), are specified as probit:

(1) $$y_i = 1(\mathbf{z}_i'\boldsymbol{\alpha}_i + u_i > 0),\ \ i = 1,2.$$

The remaining $(n-2)$ equations are specified as a Tobit system:

(2) $$y_i = \max(0, \mathbf{x}_i'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2 + u_i),\ \ i = 3,...,n.$$

In equations (1) and (2), $1(\cdot)$ is a binary indicator function, $\mathbf{z}_i$ and $\mathbf{x}_i$ are exogenous vectors of explanatory variables, $\boldsymbol{\alpha}_i$ and $\boldsymbol{\beta}_i$ are conformable vectors of parameters, γ_{i1} and γ_{i2} are scalar parameters, and the error terms $\mathbf{e} \equiv [u_1,...,u_n]'$ are distributed as *n*-variate normal $\mathbf{e} \sim N(0, \boldsymbol{\Sigma})$. The covariance matrix $\boldsymbol{\Sigma}$ is defined with error correlations ρ_{ij} and standard deviations σ_i such that $\sigma_1^2 = \sigma_2^2 = 1$.

To construct the likelihood function, consider a regime in which the first $(\ell - 2)$ of the $(n-2)$ goods are zero, with an outcome $\mathbf{y} = (y_1, y_2, 0,...,0, y_{\ell+1},..,y_n)$. When $(y_1, y_2) = (0,0)$, the likelihood contribution for this regime is

(3) $$L = \int_{-\infty}^{-r_1}\int_{-\infty}^{-r_2}\int_{-\infty}^{-r_3}\cdots\int_{-\infty}^{-r_\ell} f(u_1,u_2,...,u_n)du_\ell \cdots du_3 du_2 du_1,$$

where $r_i = \mathbf{z}_i'\boldsymbol{\alpha}_i$ for *i* = 1,2, and $r_i = \mathbf{x}_i'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2$ for *i* = 3,…,*n*, and $f(u_1,...,u_n)$ is the probability density function of $u_1,...,u_n$. The likelihood contributions for other outcomes of y_1 and y_2 involve only different integration limits with respect to u_1 and u_2. The sample likelihood function for the system is the product of the likelihood contributions over the sample.

To examine the marginal effects of explanatory variables, express the Tobit equations in (2) as a conditional system

(4) $$y_i = \max(0, \mathbf{x}_i'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2 + u_i^*),\ i = 3, 4, ..., n.$$

where u_i^* are elements of error vector $\mathbf{e}_2^* \sim N(0, \boldsymbol{\Omega})$ such that $\boldsymbol{\Omega} = \boldsymbol{\Sigma}_{21}\boldsymbol{\Sigma}_{11}^{-1}\boldsymbol{\Sigma}_{11}^{-1}\boldsymbol{\Sigma}_{21}' + \boldsymbol{\Sigma}_{22}$ $-\boldsymbol{\Sigma}_{21}\boldsymbol{\Sigma}_{11}^{-1}\boldsymbol{\Sigma}_{21}'$, and $\boldsymbol{\Sigma}_{11}, \boldsymbol{\Sigma}_{22}$ and $\boldsymbol{\Sigma}_{21}$ are partitions of $\boldsymbol{\Sigma}$ with dimensions 2×2, $(n-2) \times (n-2)$ and $(n-2) \times 2$, respectively. Denote the univariate standard normal cumulative distribution function as $\Phi(\cdot)$ and the standard deviation of u_i^* as ω_i which is the squared root of the *i*th diagonal element of $\boldsymbol{\Omega}$. Then, the probability and conditional mean of y_i (for $i = 3, ..., n$) are

(5) $$\Pr(y_i > 0) = \Phi[(\mathbf{x}'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2) / \omega_i]$$

(6) $$E(y_i \mid y_i > 0) = \mathbf{x}'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2 + \omega_i \frac{\phi[(\mathbf{x}'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2) / \omega_i]}{\Phi[(\mathbf{x}'\boldsymbol{\beta}_i + \gamma_{i1}y_1 + \gamma_{i2}y_2) / \omega_i]}.$$

The unconditional mean of y_i follows from $E(y_i) = \Pr(y_i > 0)E(y_i \mid y_i > 0)$ using equations (5) and (6). The effects of explanatory variables $\mathbf{x}$, y_1 and y_2 can be derived from these expressions.

Results

The four-equation system, consisting of binary equations for food label use and perceived importance of grains and censored equations for whole and refined grains, is estimated by maximizing the likelihood function described above. There are four alternative variables representing the use of food labels — the list of ingredients, short phrases, nutrition panel, and health claims. These alternative specifications of label use produce similar results.

For brevity, we only present the results for using short phrases. This is because a short-phrase example is related to the fiber content of foods. Whole grains are known for their rich fiber content.

Maximum-likelihood estimates for the equation system are reported in table 2. Among the six error correlation coefficients, four are significant at the 1% level of significance. Specifically, the error correlations are significant between the food-label use and knowledge equations and between the two consumption equations. The error terms of the two binary equations are also correlated with that of the whole-grain equation, suggesting endogeneity of food-label use and perceived importance in affecting the consumption of whole grains. There is no evidence of endogeneity of these binary variables in the refined-grains equation. About two-thirds of the variables are significant (at the 10% level or lower) in the food-label use and perceived importance equations, and over half of the variables are significant in the two consumption equations. In addition, both food-label use and perceived importance are significant in the whole-grain equation, while perceived importance is also significant (but not food-label use) in the refined-grain equation.

The use of food labels and perceived importance of consuming plenty of grains are affected by household financial and human capital, demographics, life style, diet/health attitude, and the respondent's role in the household. Household income, as a percent of the poverty level, is found to affect the use of food labels but not the perceived importance of grain consumption. Gender, age, and race/ethnicity have some effects on these two decision variables. Compared with their respective counterparts, males are less likely to use food labels and younger adults tend to perceive grain consumption as important. Compared with Whites, Blacks are less likely to perceive grain consumption as important. The use of food labels and perceived importance of grain consumption rise with educational attainment. As expected, when a household member is on a special diet, the respondent is more likely to use food labels in grocery shopping. Meal planners and respondents who engage in vigorous exercise at least twice a week are more likely to use food labels and to perceive grain consumption as important. Conversely, smokers and people who subscribe to the notion that body weight is predetermined are less likely to use food labels and to perceive consuming plenty of grains as important.

The parameter estimates are used to calculate the effects on the probability as well as conditional and unconditional levels of whole- and refined-grain consumption, based on equations (5) and (6) described above. Results are presented in table 3. The use of food labels and perceived importance are found to greatly influence the probability and mean level of whole-grain consumption. Compared with others, food-label users and those who perceive grain consumption as important are 15 and 31 percent more likely to consume whole grains. Among whole-grain consumers, food-label users and those who perceive grain consumption as important consume 0.09 and 0.19 more serving of whole grains. Overall, this increased probability together with a higher mean level of whole-grain consumption results in a total increase in whole-grain consumption by 0.12 more serving when a respondent switches from a nonuser of food labels to a user. A switch from perceiving consuming plenty of grains as not important to important is expected to result in an increase in whole-grain consumption by 0.22 serving. Label use has no effect on refined-grain consumption, in terms of either probability or amount. Those who perceive grain consumption as important are only 1% more likely to consume and consume about 0.20 more serving (0.19 more serving conditional on consumption) of refined grains than those who perceive otherwise.

The variables that affect the use of food labels and/or perceived importance may have both indirect and direct effects on grain consumption. Household income has no direct effect on grain consumption, but it has an indirect effect on whole-grain consumption channeled through food label use. Education and several other variables are found to affect label use and perceived importance so they have indirect effects on grain consumption. Our results are consistent with the finding that whole-grain consumption rises with education (Bhargava and Hays). All else equal, males are more likely to consume both whole and refined grains and consume at higher levels, compared with females. This positive direct association between males and the probability of consuming whole grains will be cancelled out by the negative indirect association channeled through label use, resulting in an ambiguous total effect of males on consumption probability. Compared with younger adults, seniors aged 61 and older are more (less) likely to consume whole (refined) grains and consume at a higher (lower) level. Little differences in terms of probability and level of consumption can be detected among younger adults. Asians show the strongest preference for refined grains over whole grains. Compared with Whites, Blacks are less likely to consume grains (either refined or whole) and consume at lower levels. There are regional variations in grain consumption. Relative to other consumers, consumers living in the Western states register the strongest preference for whole grains over refined grains.

Household structure is classified into four categories — dual- or single-headed with or without children, with single-person household being the reference group. Respondents from households with children (dual headed or single headed) are less likely to consume and consume fewer servings of whole grains. This is consistent with past findings that children prefer to consume white bread (Harnack, Walters, and Jacobs; Moutou, Brewster, and Fox).

Concluding Remarks

Responding to mounting evidence of the association between whole-grain consumption and a reduced risk of heart problems and other diseases as well as body weight maintenance, the U.S. Government has strongly encouraged its citizens to increase consumption of whole grains. However, Americans tend to over-consume refined grains and under-consume whole grains. Compared against the 2005 Federal dietary recommendations, an average American consumed about the right amount of grain products in 1994-96 but the balance between refined and whole grains departed notably from the recommended half-and-half pattern. Only 6 percent of Americans met the current recommended whole-grain consumption in 1994-96.

The food manufacturing sector has quickly responded to the Federal call for more whole-grain consumption. In anticipation of the 2005 *Dietary Guidelines* and consumers' reactions to them, many companies launched new branded packaged foods with higher whole-grain contents in 2004 (Buzby, Farah, and Vocke). For example, General Mills reformulated all its breakfast cereals to whole grains, Nestle launched a frozen entrée line made with 100-percent whole grains, and Sara Lee launched its Heart Healthy Plus line of fortified, 100-percent whole-wheat and multigrain breads. That same year, ConAgra introduced a new whole-grain flour called "Ultragrain White Whole Wheat." Increased supply may generate greater demand. Obviously, there are other factors that will influence consumers' acceptance of whole grains, including price and taste.

To close the huge gap between actual and recommended consumption of whole grains, effective nutrition education campaigns are needed. The Federal Government has revamped its Food Guide Pyramid with MyPyramid (USDA 2005), which provides useful tips to incorporate whole grains into our diet. Findings reported in this article can be used to design effective education campaign for increasing whole grain consumption. For example, children are known to prefer white breads and our results show that adults from households with children tend to prefer refined grains over whole grains. Apparently, adults and children from the same household eat alike. Children's food choices are also known to be influenced by TV commercials (Hastings et al.). Therefore, nutritional messages appealing to children during the hours when children watch TV are likely to be effective in encouraging children and their parents to consume more whole grains. As the use of food labels and the perceived importance of grain consumption have been found to affect the likelihood of consuming whole grains and the amount consumed, messages to encourage the use of food labels and to educate consumers the benefit of consuming grains, especially whole grains, will help reaching the recommendation for whole-grain consumption.

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Table 1. Variable Definitions and Sample Statistics (*n* = 5,501)

Variable	Definition	Mean	S.D.
Whole grains	Daily consumption of whole grains (servings), 2-day average	0.28	0.34
	Consuming sample (*n* = 4003)	0.38	0.34
Refined grains	Daily consumption of refined grains (servings), 2-day average (99.8% consuming)	1.34	0.61
Income	Household income as percent of poverty	160.90	137.10
Male	Respondent is male (0,1)	0.50	0.50
Age 20–30	Respondent aged 20–30 (0,1)	0.14	0.35
Age 31–40	Respondent aged 31–40 (0,1)	0.18	0.38
Age 41–50	Respondent aged 41–50 (0,1)	0.18	0.38
Age 51–60	Respondent aged 51–60 (0,1)	0.18	0.38
Age > 60	Respondent aged 61 and up (0,1) (reference)	0.32	0.47
Black	Respondent is non-Hispanic Black (0,1)	0.11	0.32
Hispanic	Respondent is Hispanic (0,1)	0.08	0.27
Asian	Respondent is Asian Pacific Islander (0,1)	0.02	0.12
Other	Respondent's is none of the above nor White (0,1)	0.01	0.11
White	Respondent is non-Hispanic White (0,1) (reference)	0.78	0.41
HH type 1	Household is dual-headed, with children (0,1)	0.28	0.45
HH type 2	Household is dual-headed, without children (0,1)	0.36	0.48
HH type 3	Household is single-headed, with children (0,1)	0.08	0.27
HH type 4	Household is single-headed without children (reference)	0.28	0.45
Quarter 1	Dietary recalls taken in January–March (0,1)	0.23	0.42
Quarter 2	Dietary recalls taken in April–June (0,1)	0.26	0.44
Quarter 3	Dietary recalls taken in July–September (0,1)	0.28	0.45
Quarter 4	Dietary recalls taken in October–December (reference)	0.24	0.43
Size	Number of persons in the household	2.56	1.46
Midwest	Respondent resides in the Midwestern states (0,1)	0.25	0.44

South	Respondent resides in the Southern states (0,1)	0.35	0.48
West	Respondent resides in the Western states (0,1)	0.20	0.40
Northeast	Respondent resides in the Northeastern states (0,1): reference	0.19	0.39
Rural	Respondent resides in rural areas (0,1)	0.27	0.44
Suburb	Respondent resides in a suburb (0,1)	0.44	0.50
City	Respondent resides in central city (0,1) (reference)	0.30	0.46
High school	Respondents completed high school education (0,1)	0.34	0.47
Some college	Respondents attended college for less than 4 years (0,1).	0.21	0.41
College	Respondents had 4 or more years of college education (0,1)	0.23	0.42
< high school	Respondent did not complete high school (reference)	0.22	0.41
Special diet	A family member is on a special diet (0,1)	0.27	0.45
Meal planner	Respondent is main meal planner of household (0,1)	0.70	0.46
Exercise	Respondent exercised vigorously at least twice a week (0,1)	0.48	0.50
Smoker	Respondent smokes cigarettes (0,1)	0.26	0.44
Gene theory	Respondent agrees with statement that some are born to be fat (0,1)	0.44	0.50

Table 2 . Parameter Estimates of a Demand System for Refined and Whole Grain Products with Endogenous Food Label Use and Health Belief

	Label use – short claim		Perceived importance		Whole grains		Refined grains	
Variable	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	0.19***	0.07	0.48***	0.07	–0.18***	0.05	1.20***	0.07
Income × 10^{-3}	0.49***	0.15	–0.21	0.15	0.09	0.06	0.06	0.07
Male	–0.51***	0.04	0.01	0.04	0.05***	0.02	0.15***	0.02
Age 20-30	–0.06	0.06	0.15***	0.06	–0.06***	0.02	0.16***	0.03
Age 31-40	0.03	0.05	0.12**	0.06	–0.05**	0.02	0.12***	0.03
Age 41-50	0.08	0.05	0.12**	0.05	–0.06***	0.02	0.05**	0.03
Age 51-60	0.11**	0.05	0.07	0.05	–0.05***	0.02	0.05*	0.03
Black	0.01	0.06	–0.21***	0.06	–0.11***	0.02	–0.09***	0.03
Hispanic	0.12*	0.07	–0.07	0.07	0.03	0.02	–0.05	0.03
Asian	0.17	0.15	–0.12	0.15	–0.24***	0.05	0.49***	0.05
Other	0.25	0.18	0.27	0.20	–0.12**	0.06	–0.04	0.08
HH type 1					–0.05**	0.03	0.01	0.03
HH type 2					–0.02	0.02	0.00	0.02
HH type 3					–0.08***	0.03	–0.03	0.04
Size					0.08	0.06	0.05	0.09
Quarter 1					0.02	0.02	0.03	0.02
Quarter 2					0.01	0.02	–0.03	0.02
Quarter 3					–0.02	0.02	–0.05**	0.02
Non-metro					–0.03	0.02	–0.08***	0.02
Suburban					–0.02	0.01	–0.01	0.02
Midwest					0.04**	0.02	–0.04*	0.02
South					0.00	0.02	–0.09***	0.02
West					0.13***	0.02	–0.19***	0.03
Label use					0.19***	0.06	–0.07	0.08
Importance					0.36***	0.06	0.20**	0.10

High school	0.17***	0.05	0.06	0.05				
Some college	0.19***	0.06	0.13**	0.06				
College	0.33***	0.06	0.37***	0.06				
Special diet	0.23***	0.04	0.06	0.04				
Meal planner	0.09**	0.04	0.13***	0.04				
Exercise	0.13***	0.04	0.13***	0.04				
Smoker	–0.28***	0.04	–0.17***	0.04				
Gene theory	–0.17***	0.04	–0.06*	0.04				
Std. dev.					0.44***	0.01	0.59***	0.01
Error correlations:								
Importance	0.15***	0.02						
Whole grains	–0.19***	0.08	–0.45***	0.06				
Refined grains	0.09	0.08	–0.15	0.09	–0.18***	0.02		

Note: Log-likelihood value = –14633.93. Asterisks ***, ** and * indicate significance at 1%, 5% and 10% levels, respectively.

Table 3. Effects of Variables on the Probability, Conditional Level and Unconditional Level of Consumption

	Whole grains			Refined grains		
Variable	Probability	Cond. level	Uncond. level	Probability	Cond. Level	Uncond. level
Income	0.02	0.02	0.03	0.00	0.01	0.01
	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)
Size	0.03	0.02	0.05	0.00	0.01	0.01
	(0.02)	(0.02)	(0.04)	(0.00)	(0.02)	(0.02)
Male	0.04***	0.03***	0.04***	0.01***	0.14***	0.15***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
Age 21–30	–0.05***	–0.03***	–0.04***	0.01***	0.15***	0.16***
	(0.02)	(0.01)	(0.01)	(0.00)	(0.03)	(0.03)
Age 31–40	–0.04**	–0.02**	–0.03**	0.01	0.12	0.13
	(0.02)	(0.01)	(0.01)	(0.00)	(0.03)	(0.03)
Age 41–50	–0.05***	–0.03***	–0.04***	0.00**	0.05**	0.05**
	(0.02)	(0.01)	(0.01)	(0.00)	(0.03)	(0.03)
Age 51–60	–0.04***	–0.02***	–0.04***	0.00*	0.04*	0.05*
	(0.02)	(0.01)	(0.01)	(0.00)	(0.02)	(0.03)
Black	–0.09***	–0.05***	–0.07***	–0.01***	–0.08***	–0.09***
	(0.02)	(0.01)	(0.01)	(0.00)	(0.03)	(0.03)
Asian	–0.21***	–0.10***	–0.14***	0.01***	0.47***	0.49***
	(0.05)	(0.02)	(0.03)	(0.00)	(0.05)	(0.05)
Other	–0.10*	–0.05**	–0.07**	0.00	–0.04	–0.04
	(0.05)	(0.02)	(0.03)	(0.01)	(0.07)	(0.08)
Hispanic	0.02	0.01	0.02	0.00	–0.04	–0.05
	(0.02)	(0.01)	(0.02)	(0.00)	(0.03)	(0.03)
Midwest	0.03**	0.02**	0.03**	0.00*	–0.04*	–0.05*
	(0.02)	(0.01)	(0.01)	(0.00)	(0.02)	(0.03)
South	0.00	0.00	0.00	–0.01***	–0.08***	–0.09***
	(0.02)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
West	0.10***	0.07***	0.09***	–0.01***	–0.18***	–0.19***
	(0.02)	(0.01)	(0.02)	(0.00)	(0.02)	(0.03)

Non-metro	–0.02	–0.01	–0.02	0.00***	–0.07***	–0.08***
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
Suburban	–0.02	–0.01	–0.01	0.00	–0.01	–0.01
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
HH type 1	–0.04**	–0.02**	–0.03**	0.00	0.01	0.01
	(0.02)	(0.01)	(0.02)	(0.00)	(0.03)	(0.04)
HH type 2	–0.02	–0.01	–0.02	0.00	0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
HH type 3	–0.07***	–0.04***	–0.05***	0.00	–0.03	–0.03
	(0.03)	(0.01)	(0.02)	(0.00)	(0.04)	(0.04)
Quarter 1	0.02	0.01	0.01	0.00	0.03	0.03
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
Quarter 2	0.01	0.00	0.01	0.00	–0.03	–0.03
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
Quarter 3	–0.02	–0.01	–0.01	0.00**	–0.04**	–0.05**
	(0.01)	(0.01)	(0.01)	(0.00)	(0.02)	(0.02)
Label use	0.15***	0.09***	0.12***	0.00	–0.06	–0.07
	(0.05)	(0.03)	(0.04)	(0.00)	(0.07)	(0.08)
Importance	0.31***	0.15***	0.22***	0.013*	0.19**	0.20**
	(0.04)	(0.02)	(0.03)	(0.009)	(0.09)	(0.10)

Note: Effects of income and household size were calculated as marginal effects. All other explanatory variables are discrete (see text for details on calculation of discrete effects). Asymptotic standard errors in parentheses. Asterisks ***, ** and * indicate significance at the 1%, 5% and 10% levels of significance, respectively.