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Dietary Fiber

Effects of Socioeconomic Characteristics and Knowledge

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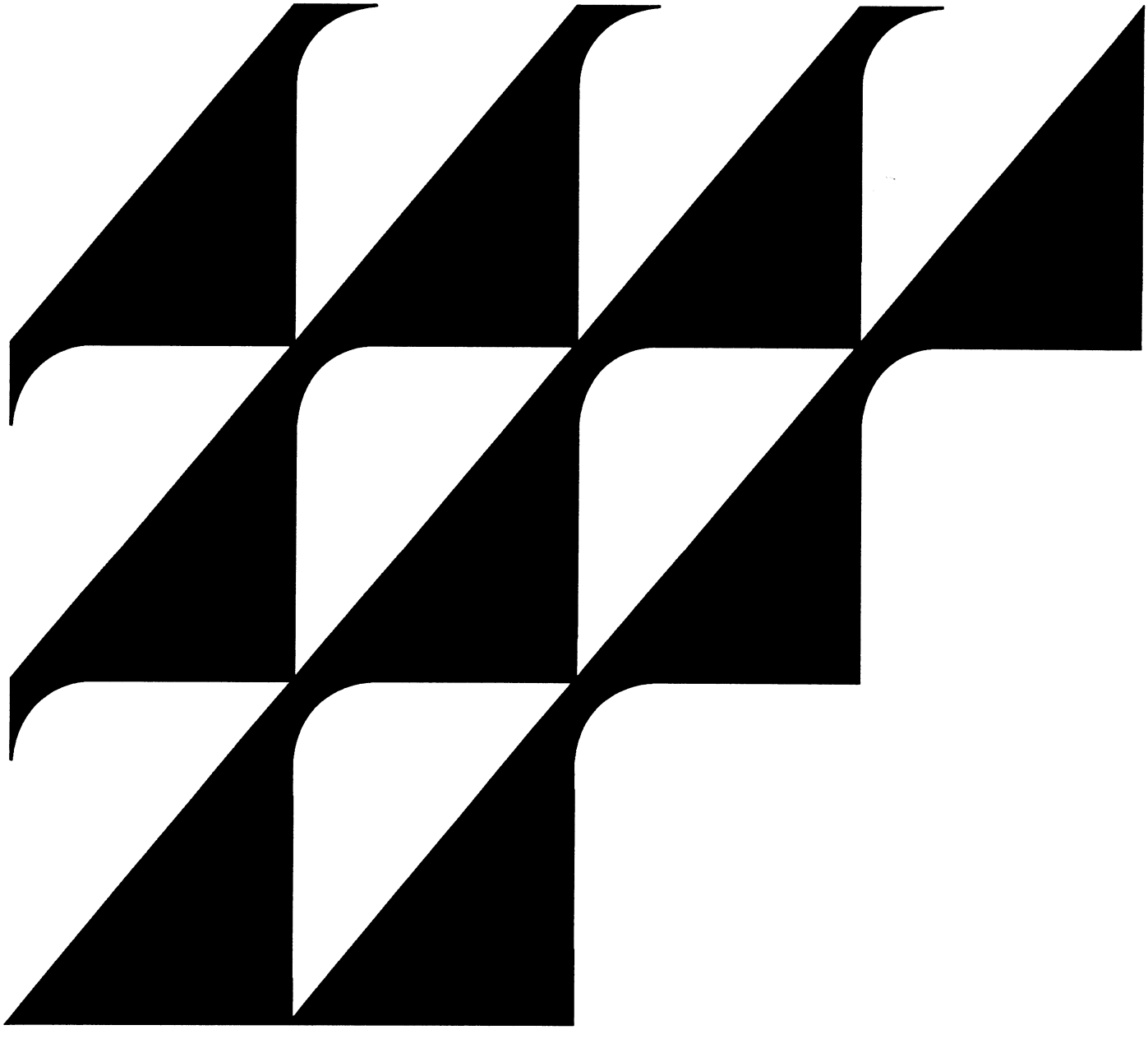

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Abstract

Effective nutrition education programs require a knowledge of the socioeconomic characteristics of current and potential participants, their current levels of nutrient consumption, and their knowledge of health issues related to diet. The main meal planners in American households consume about 10-13 grams of fiber per day, about half the recommended amount. Meal planners who consume more fiber than average tend to be male, older white, or Hispanic, have more than a high school education, and live in rural areas. Meal planners who consume less fiber than average tend to be black, reside in the North Central States or the West, live in large households, smoke, or participate in the Food Stamp program or the Women, Infants, and Children program. The data are from the 1989-90 U.S. Department of Agriculture's Continuing Survey of Food Intake of Individuals and the Diet Health Knowledge Survey.

Keywords: Fiber consumption, demographics, latent variables

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Summary

Effective nutrition education programs require a knowledge of the socioeconomic characteristics of current and potential participants, their current levels of nutrient consumption, and their knowledge of health issues related to diet. The main meal planners in American households consume about 10-13 grams of fiber per day, about half the recommended amount. Meal planners who consume more fiber than average tend to be male, older white, or Hispanic, have more than a high school education, and live in rural areas. Meal planners who consume less fiber than average tend to be black, reside in the North Central States or the West, live in large households, smoke, or participate in the Food Stamp program or the Women, Infants, and Children program. The data are from the 1989-90 U.S. Department of Agriculture's Continuing Survey of Food Intake of Individuals and the Diet Health Knowledge Survey.

About 85 percent of the main meal planners surveyed thought that diet influences health. Fifty-nine percent thought that their current diets were healthy, while 40 percent of all meal planners thought that their diets should contain more fiber. In terms of specific knowledge about which foods are high in fiber, the majority of meal planners were able to correctly identify foods that are high in fiber.

Consumption of fiber increases with age. Meal planners under age 30 in 1989-90 consumed 10.5 grams of fiber daily, while those over 70 consumed 13.1 grams. Whites and other nonblacks consumed about 12.3 grams of fiber, while blacks consumed about 9.5 grams. Two food categories (cereal and bakery products, and vegetables and potatoes) provided the bulk of dietary fiber.

This study is based on data collected on a subsample of meal planners in the 1989-90 U.S. Department of Agriculture Continuing Survey of Food Intake of Individuals and the companion Diet-Health Knowledge Survey.

Dietary Fiber: Effects of Socioeconomic Characteristics and Knowledge

Noel Blisard, James Blaylock, and David Smallwood

Introduction

Scientific evidence linking diet and health has developed rapidly, and it is now well established that individual dietary choices are important determinants of health. Further evidence of the strength of the diet-health linkage is dramatically provided by McGinnis and Foege, who estimated that together dietary factors and sedentary activity patterns account for at least 300,000 premature deaths per year in the United States. Doll and Peto estimated that 35 percent of all cancer deaths are attributable to diet. On the positive side, an assessment of the decline in coronary artery disease mortality from 1968 to 1976, by Goldman and Cook, credits a reduction in serum cholesterol levels with about one-third of the improvement. In spite of the volume and diversity of nutrition and health-related studies, one consistent theme emerges: Some diets and some diseases are linked.

One nutrient that has been linked to reduced incidences of heart disease and some cancers is fiber. Elevated blood cholesterol levels are known to be one of the chief risk factors in heart disease, and a number of studies have linked diets high in soluble fiber with reduced blood cholesterol levels (appendices I and II contain discussions of dietary fiber and the advantages of a high-fiber diet). Also, "eating foods with fiber is important for proper bowel function and can reduce symptoms of chronic constipation, diverticular disease, and hemorrhoids," according to *Nutrition and Your Health: Dietary Guidelines for Americans* (USDA). The guidelines suggest that a diet low in dietary fiber may increase one's risk of developing certain types of cancer.

Even though research on the link between dietary fiber and health is not sufficiently developed to associate a specific type of fiber or characteristic of fiber (such as particle size, chemical composition, or water-holding capacity) with reducing health risks, the most recent *Surgeon General's Report on Nutrition and Health* advises Americans to increase consumption of all complex carbohydrates, including dietary fiber. Despite intensive efforts by nutritionists, manufacturers, and others in the health care industry to spread the word about the virtues of fiber, intakes remain below the levels recommended by some health authorities. Americans consume about 10-13 grams of dietary fiber per day, far below the National Cancer Institute's recommendation of eating foods that provide 20-30 grams of fiber per day. About 50 percent of meal planners in a recent survey, however, were aware of health problems associated with low-fiber intake, while 40 percent of all meal planners thought their diets should contain more fiber.

One might expect fiber intake to increase as a person becomes aware of the potential long-term health benefits of a diet high in fiber. It is not clear, however, if such knowledge is shared by the general population, or if such knowledge is concentrated within certain segments of society such as higher income groups, or by race, region, or age, among other variables. Understanding how nutritional knowledge varies across different population groups and the effect of knowledge on consumption levels is critical for designing and evaluating nutrition education programs and monitoring the Nation's progress in moving toward dietary goals.

This report presents an initial investigation into the relationships between knowledge, attitudes, awareness, and fiber intake. Some of the questions we address include: Is there any connection between one's fiber knowledge and/or awareness and one's actual intake? Why is fiber intake low, and does it vary systemically among different socioeconomic and demographic groups? And are there any population groups that systemically know little about fiber and its relationship to a healthy diet? Specifically, we focus on studying the association between fiber intake and a person's socioeconomic and demographic characteristics, fiber knowledge levels, and knowledge of health problems associated with reduced fiber consumption.

We used data from USDA's 1989-90 Diet and Health Knowledge Survey (DHKS) and its associated Continuing Survey of Food Intake by Individuals (CSFII) in a preliminary attempt to answer some of these questions. The CSFII survey collects

information on what Americans eat and how much they eat, as well as personal health-related data. The DHKS, a follow-up survey to the CSFII, collects information from the household's main meal planners/preparers on their attitudes and knowledge about food and nutrition and related health issues. These surveys are among the first to provide information on nutritional knowledge and attitudes, as well as on food and nutrient consumption for the same individual.

A system of behavioral equations is estimated that isolates the net effect of income, fiber/dietary knowledge, and other socioeconomic characteristics on per capita fiber consumption. We also study variations in levels of fiber knowledge, attitudes, and awareness that are systematically associated with demographic and socioeconomic characteristics.

Theoretical and Empirical Considerations

The classical theory of consumer demand postulates that a consumer maximizes a utility function subject to a budget constraint. The result of this process is a set of demand relations, one for each commodity, which are functions of all prices and income. Several restrictions have been shown to apply to demand functions. Few empirical analyses, however, have attempted to estimate a complete demand system for food, much less nutrients such as fiber. Notable exceptions include Brandow; George and King; Eastwood, Brooker, and Terry; and Huang. Estimation of complete demand systems requires information on prices for every commodity as well as household income. If the focus of the analysis is on multiple commodities or nutrients and if variables other than prices and income are incorporated, the data requirements quickly become so extensive that the analysis becomes almost unmanageable. Hence, the majority of empirical analyses of consumer demand have focused on single-equation demand relations.

This study uses the theory of household production to incorporate knowledge and awareness of diet-health relationships directly into a single-demand equation for a nutrient. The basic idea is that a person or household combines information, time, and market goods to produce commodities that yield utility. In this approach, people can be viewed as production units producing a number of commodities, some perhaps unobserved, in such a way as to maximize their well-being. Demand functions for market goods are derived from the demand for these "home-produced" commodities and are constrained by the individual's production technology and limited resources.

Hence, one may think of a person maximizing a utility function:

$$U = U(H,L,Z), \qquad U'>0,\ U''<0, \tag{1}$$

where H, L, and Z are, respectively, vectors of health status, leisure, and other household consumption.

Health status is a function of the type of nutrients consumed as well as other health-related inputs, such as genetic endowment and purchased health services. Since we are primarily interested in a person's fiber consumption, we focus only on nutrient input decisions in the implementation of the model. The production function for health may be denoted as:

$$H = H(N,Y,X), \tag{2}$$

where N is a vector of nutrients consumed, Y is a vector of nonfood health inputs such as medical services, and X is a vector of health-relevant personal characteristics that are observable. Note that N, the nutrients consumed, is itself a function of F, the foods consumed. Hence, the health production function may be written:

$$H = H(N(F),Y,X). \tag{3}$$

Therefore, a person has a demand function for nutrients that is a function of prices, income, and possibly other socioeconomic variables (Pitt and Rosenzweig), and which can be written:

$$N = N(P_f,\ P_z,\ I,\ D), \tag{4}$$

where P_f is the price of food, P_z is the price of nonfood items, I is income, and D is a vector of other socioeconomic variables.

We assume that a person's dietary knowledge, such as knowing the benefits of eating a high-fiber diet and knowing which foods contain fiber, influences the production of health and directly affects the person's choice of food inputs. In other words, knowledge alters the technology of production, thereby changing the demand for the various nutrients (Jensen, Kesavan, and Johnson). This knowledge can be introduced as an exogenous factor into the consumer demand function for a particular nutrient. In this study, the particular nutrient we focus upon is fiber. Thus, the demand for fiber can be expressed as a function of food prices, income, diet-health awareness and knowledge, and other socioeconomic variables and may be denoted as:

$$N = N(P_f, P_z, I, D, K), \tag{5}$$

where K is dietary knowledge.

Data

The 1989-90 DHKS-CSFII of the U.S. Department of Agriculture's Human Nutrition Information Service (HNIS) is the source of data used in this analysis. The DHKS-CSFII is the most recent and complete data available on nutrient intake of individuals in U.S. households. The survey gathers information on the attitudes and knowledge about nutrition, diet, and health of households' main meal planners or preparers (referred to hereafter as the main meal planners). The DHKS was designed so that information from it could be linked to information on food consumption from USDA's CSFII. This combined information allows researchers to analyze how individual attitudes and knowledge about healthful eating affect food choices and dietary status. The 1989-90 CSFII provides dietary data covering 3 consecutive days for individuals of all ages. The first day's data were collected in a personal in-home interview using a 1-day dietary recall of food intake. The second and third days' data are from a 2-day dietary record kept by the respondents. Personal data (such as income, age, race, and education) were also collected, as were self-reported health status, weight, and height information.

The 1989 and 1990 DHKS were conducted as a telephone followup to the CSFII. Individuals identified in the CSFII as the main meal planners for the household were contacted about 6 weeks after the CSFII and asked a series of questions about health and diet. The analysis presented here applies only to the main meal planners with 3 days of complete dietary intake information, and may not be representative of the population. This subsample was chosen to maintain the close link between dietary intake and diet-health knowledge and awareness information.

Descriptive Statistics

In the 2,480 households surveyed in 1989-90, 80 percent of the main meal planners were women (table 1). The average age was 48 years, and the average per capita income was about $196 per week. The average household size was about 2.6 people. Approximately 86 percent were white, and 7 percent identified themselves as Hispanic. The majority of those interviewed had obtained a high school education, and 27 percent of the respondents smoked.

The DHKS revealed that about 85 percent of the meal planners believed that what they ate could make a difference in their chances of getting a disease; about 15 percent disagreed. About 59 percent of the meal planners felt their diet was healthful and saw no need to change. In contrast, about 40 percent disagreed with the statement that their diet was healthful and change was not necessary.

When it came to fiber, 40 percent of the meal planners thought their diets should contain more. Fifty percent of the meal planners indicated that they were aware of health problems associated with low-fiber intake. Of those, 15 percent mentioned circulation and heart problems, 40 percent mentioned cancer, and about 56 percent said bowel problems.

Given a choice of two foods, 80 percent of the meal planners were able to identify which was higher in fiber in about five out of six cases (exceeding the Federal Government's goal that by 1990, 70 percent of the population would be able to identify foods that are good sources of fiber). Seventy-seven percent of the meal planners knew that fruit contained more fiber than meat, while 79 percent knew that oatmeal cereal had more fiber than cornflakes. The vast majority (91 percent)

Table 1--Selected descriptive statistics, 1989-90

Variable	Unit	Mean		Standard error
North Central	Percent	25		44
South	Percent	38		48
West	Percent	19		39
Smoke	Percent	27		40
Female	Percent	80		40
Age	Years	48.02		18.56
Household size	Number	2.57		1.59
White	Percent	86		34
Hispanic	Percent	7		26
Education	Index[1]	2.11		1.18
Income per person per week	$100's	1.96		1.92
Rural residence	Percent	30		46
Male meal planners	Percent	12		32
Program[2]	Percent	15		38
Food eaten now is healthful	Percent	59 agree		49
What one eats affects one's health	Percent	85 agree		36
Aware of problems of a low-fiber diet	Percent	50 agree		50
Thinks diet should be higher in fiber	Percent	40 agree		18
Which has more fiber?		Correct	Food	
Fruit or meat?	Percent	77	Fruit	42
Cornflakes or oatmeal?	Percent	79	Oatmeal	41
Wheat or white bread?	Percent	91	Wheat	29
Orange juice or an apple?	Percent	73	Apple	44
Kidney beans or lettuce?	Percent	57	Kidney beans	50
Popcorn or pretzels?	Percent	77	Popcorn	42

[1]Education = 1 if respondent has less than a high school education,
Education = 2 if respondent has a high school education,
Education = 3 if respondent has attended college,
Education = 4 if respondent graduated from college, and
Education = 5 if respondent attended graduate school.
[2]Respondent received food stamps or participated in the Women, Infants, and Children (WIC) program.

were aware that wheat bread had more fiber than white bread. Only 57 percent of the respondents, however, were aware that kidney beans contained more fiber than lettuce, while 77 percent knew that popcorn contained more fiber than pretzels.

Income, education, and gender appear to be associated with knowledge about sources of fiber (table 2). For example, out of the six fiber questions, the highest income meal planners answered an average of 5.2 questions correctly, compared with 4.3 for the lowest income group. Meal planners with at least some college background answered about 5.2 questions correctly, while those with less than a high school education correctly identified only 4.2. In addition, females answered 4.9 questions correctly, while males averaged 4.4 correct answers.

On average, meal planners in 1989-90 consumed about 12 grams of fiber per day, which is well below the widely recommended 20-30 grams per day (table 3). Actual consumption of fiber, however, increases with age. Meal planners under age 30 consumed 10.5 grams of fiber daily, while those over age 70 consumed 13.1 grams. Both whites and other

Table 2--Number of correct answers in fiber comparisons, 1989-90

Group	Average number of correct answers (out of six)
	Number
All	4.8
Age:	
Under 30 years	4.7
30-49 years	5.0
50-69 years	4.9
70 years and over	4.5
Sex:	
Male	4.4
Female	4.9
Race:	
White	4.8
Black	4.9
Other	4.5
Per capita income:	
$3,800 or less	4.3
$3,801-$5,400	5.0
$5,401-$10,200	4.8
Over $10,200	5.2
Education:	
Less than high school	4.2
Completed high school	4.9
More than high school	5.2

Table 3--Sources of fiber in daily diet by age, race, and income, 1989-90

Group	Total fiber intake	Meat, poultry, fish, and eggs	Cereal and bakery	Legumes, nuts, and seeds	Fruit	Vegetables and potatoes	Other
	Grams	*Percent*					
All	12.0	7	42	8	11	28	4
Age:							
Under 30 years	10.5	8	45	7	8	27	5
30-49 years	10.8	7	43	7	10	28	5
50-69 years	12.7	6	40	10	13	30	3
70 years and over	13.1	5	41	8	16	28	2
Race:							
White	12.3	7	43	8	11	28	4
Black	9.5	7	36	12	9	31	5
Other[1]	12.3	8	42	10	13	24	3
Per capita income:							
$3,800 or less	11.1	7	39	13	10	28	3
$3,801-$5,400	12.5	7	42	6	11	29	5
$5,401-$10,200	11.2	7	41	8	11	29	4
Over $10,200	13.0	7	44	7	12	27	4

[1]"Other" includes Aleuts, Eskimos, American Indians, Asian/Pacific Islanders, and other nonwhite and nonblack.

nonblacks consumed about 12.3 grams of fiber daily, while blacks consumed about 9.5 grams. Fiber consumption appears to be positively correlated with income. Meal planners with the lowest income consumed about 11.1 grams of fiber per day, while those with the highest level of income consumed about 13 grams per day.

Regardless of a person's age, race, or income, two food categories provided the bulk of dietary fiber. Meal planners received an average of 42 percent of their dietary fiber from cereal and bakery products, and 28 percent from vegetables and potatoes (table 3). (The food groups used were developed by USDA's Human Nutrition Information Service. In general, mixtures, such as TV dinners and casseroles, are categorized by their primary ingredient.)

The percentage of total dietary fiber received from any given food category varied with individual characteristics. For example, black meal planners received 36 percent of their fiber from cereal and bakery products, and 31 percent from vegetables and potatoes, versus 43 and 28 percent, respectively, for white meal planners.

Older meal planners tended to receive more of their fiber from fruit (16 percent for those over age 70, compared with 8 percent for those under age 30). Meal planners in the highest income households tended to receive less fiber from legumes, nuts, and seeds than did those with the lowest incomes. Instead, the highest income meal planners received more fiber from fruit, and from cereal and bakery products.

Model Specification and Variables

Our modeling efforts are focused on increasing our understanding of the associations between fiber intake of meal planners and their socioeconomic characteristics, fiber and diet knowledge, and income. We also explore systematic variations in fiber and diet knowledge that are associated with individual socioeconomic characteristics and income.

As a caveat, due to the complexity of the relationship between commodity (food) prices and fiber intake as well as the lack of price data, this aspect of modeling fiber intake was left for future study. Since there are many alternative sources of fiber, however, the ability to substitute one food for another should limit the effect of individual food prices. Fiber intake is modeled as a function of income, relevant household characteristics, and fiber/diet knowledge.

Socioeconomic variables included in the model are region of residence, race, whether or not the respondent is Hispanic, age, household size, whether or not the main meal planners were males, whether or not the main meal planners participated in the Women, Infants, and Children program (WIC) and/or received food stamps (this combination variable is called "program" in the model), and whether or not the household resided in a rural location (Capps and Schmitz; Jensen, Kesavan, and Johnson).

The region of household residence, race, rural location, Hispanic, male, and program variables are all entered as binary variables. Household region is entered into the equation to capture regional consumption differences that may affect the amount of fiber consumed. Likewise, the race and Hispanic variables are used to capture culturally different consumption patterns between whites and nonwhites as well as Hispanics. We hypothesized that rural residents may also have different consumption patterns from their suburban and urban counterparts, perhaps due to food production from gardens and orchards and well-known differences in at-home and away-from-home eating patterns. Generally, males consume more food and thus more fiber than females on average, so the male head variable (that is, the main meal planner is male) was entered into the model to control for this effect. We hypothesized that households that either participate in the WIC program or receive food stamps, or both, may also receive information on nutritious, healthful diets. These households are also more likely to be at nutritional risk due to limited resources to purchase food. Hence, we thought it was possible that this segment of society might consume different amounts of fiber than others.

We hypothesized that larger households may purchase a different mix of goods than smaller households, thereby altering the intake of fiber of the main meal planners. Variations in size of households were controlled for by entering household size directly into the equation. We hypothesized that fiber consumption may increase with age, so age was entered into the model to control for this effect. Finally, we control for income by entering per capita weekly income directly into the equation.

Dietary knowledge and awareness of diet/disease relationships represent unique and challenging variables. They are inherently abstract concepts with many dimensions, none of which can be directly observed. One can, however, observe

various manifestations or outcomes that can serve as indicators of the underlying facets of knowledge. Unobserved variables, like knowledge, are referred to as latent variables and several techniques exist that allow researchers to estimate models with unobserved variables. These techniques include principal components, factor analysis, multiple indicators multiple cause, and linear structural equations. After considerable study of our data and the information requirements for each of the above model specifications, we entered two proxies for knowledge directly into the fiber consumption equation: a proxy for specific fiber knowledge and one for general fiber knowledge.

There are several questions on the DHKS whose answers would indicate a general knowledge about foods containing fairly large amounts of fiber. Two questions in particular were singled out. One asked the respondent if it was important to eat five or more fruits and vegetables a day. The other dealt with whether or not it was important to eat plenty of grain-type foods. We created a binary variable equal to 1 if the response to both questions was positive and zero otherwise. We label this variable as general fiber knowledge (GFK).

The second set of questions is directly concerned with fiber consumption. The first asked the respondents if they had heard about any health problems that might be related to how much fiber a person eats. The other asked the respondents to identify which of two foods contains more fiber. We again created a binary dummy variable if the respondent provided a positive answer about awareness of any health problems with fiber and if the respondent was able to answer correctly four or more of the six fiber comparison questions. We refer to this variable as specific fiber knowledge variable (SFK). The calculated means for GFK and SFK are 0.40 and 0.43, respectively. While the sample means are quite close, the data suggest that these are really two very distinct variables. The tetrachoric correlation between these two binary variables is not statistically different from zero (-0.028) and only 17.5 percent of the same households were assigned a 1 for both the GFK and SFK variables.

We assume that it is possible for both knowledge variables and fiber consumption to be correlated, implying a simultaneous system of equations. To simplify matters, we assumed that the two knowledge equations could be estimated as a bivariate probit model and that the predicted probabilities from both could be used as instruments in order to estimate the fiber equation by a two-stage process. Given our assumptions, this method provides asymptotic standard errors for the demand equation.

We specified both knowledge variables to be a function of region of residence, race, whether or not the respondent is Hispanic, age, household size, highest education level attained, whether or not the household resides in a rural area, whether or not the main meal planner is male, whether or not the meal planner smokes, and finally whether or not the household participates in WIC or receives food stamps. All variables are the same as those in the demand for fiber equation, except for education and whether or not the respondent smokes. We hypothesized that people with more education might be more aware of diet issues and the role fiber plays in the diet. Conversely, we assumed that people who smoke might be less aware of diet issues or less concerned than nonsmokers about the role of diet in health status. The three-equation system for general and specific fiber knowledge and fiber intake is specified as:

$$
\begin{aligned}
GFK &= B_{10} + B_{11}S + B_{12}NC + B_{13}W + B_{14}Race \\
&\quad + B_{15}HS + B_{16}Age + B_{17}Rural + B_{18}ED \\
&\quad + B_{19}Smk + B_{110}Hisp + B_{111}Program \\
&\quad + B_{112}Mhead + \epsilon_1 \\
-SFK &= B_{20} + B_{21}S + B_{22}NC + B_{23}W + B_{24}Race \\
&\quad + B_{25}HS + B_{26}Age + B_{27}Rural + B_{28}ED \\
&\quad + B_{29}Smk + B_{210}Hisp + B_{211}Program \\
&\quad + B_{212}Mhead + \epsilon_2 \\
Log(Fiber) &= B_{30} + B_{31}S + B_{32}NC + B_{33}W + B_{34}Race \\
&\quad + B_{35}HS + B_{36}Age + B_{37}Rural \\
&\quad + B_{38}Hisp + B_{39}Program + B_{310}Mhead \\
&\quad + B_{311}Income + B_{312}GFK + B_{313}SFK + \epsilon_3.
\end{aligned}
\tag{6}
$$

Variable definitions are presented in table 4. The means of these variables can be found in table 1.

Empirical Results

Estimated parameters for the three equations are presented in table 5. Preliminary analysis indicated that the two probit equations for fiber knowledge were independent of each other (-0.009 correlation and statistically insignificant) and were therefore estimated separately. The following discussion will focus upon those variables that are statistically significant at the 10-percent level or higher.

In the general fiber knowledge equation only three independent variables were statistically significant: age, male head, and program participation status. Each of these variables has the anticipated sign. That is, older meal planners are associated with a higher probability of being knowledgeable about fiber in general (significant at the 2-percent level), as are respondents who participate in the WIC or Food Stamp programs (significant at the 1-percent level). On the other hand, male meal planners are associated with a lower probability of being knowledgeable about fiber in general, perhaps because females are more apt to receive formal and informal education on food preparation and relevant diet information (significant at the 4-percent level).

In the specific fiber knowledge equation, 9 out of 12 independent variables were significant at the 10-percent level or higher. Respondents in both the North Central States and the West were associated with a higher probability of having specific knowledge about foods containing fiber than those in the Northeast or South (significant at the 1-percent level). Likewise, nonblacks tended to have more specific fiber knowledge than blacks (significant at the 1-percent level), while Hispanics were associated with a lower probability of knowledge about the fiber content of specific foods. In addition, larger households tended to have meal planners more knowledgeable about the fiber content of specific foods. As hypothesized, main meal planners with more education were associated with a higher probability of having specific fiber knowledge (significant at more than 1 percent) relative to those with less education. Again, male meal planners were less knowledgeable about specific sources of fiber than their female counterparts. Likewise, meal planners who smoked tended to be less knowledgeable about the fiber content of specific foods than nonsmokers, perhaps due to less concern for their personal health than nonsmokers (Blaylock and Blisard). Somewhat surprisingly, meal planners who participated in the WIC or Food Stamp programs were found to be less knowledgeable about specific sources of fiber than those who did not

Table 4--Variable definitions

Variable	Definition
S	Equals 1 if household resides in the South, zero otherwise
NC	Equals 1 if household resides in the North Central region, zero otherwise
W	Equals 1 if household resides in the West, zero otherwise
Race	Equals 1 if white, zero otherwise
HS	Number of persons in household
Age	Age in years
Rural	Equals 1 if household resides in rural area, zero otherwise
ED	Years of formal education
Smk	Equals 1 if smokers, zero otherwise
Hisp	Equals 1 if Hispanic, zero otherwise
Program	Equals 1 if household receives food stamps or participated in the Women, Infants, and Children (WIC), zero otherwise
Mhead	Equals 1 if meal planner was male, zero otherwise
Income	Weekly per person income in $100's
GFK	Equals 1 if meal planner thinks it is important to eat five fruits and vegetables a day, and plenty of grain-type foods, zero otherwise
SFK	Equals 1 if meal planner was aware of any health benefits associated with a high-fiber diet, and if he/she could answer at least 4 out of 6 questions about which food had more fiber than another

Table 5--Simultaneous fiber knowledge and consumption equations, 1998-90

Variable	Coefficient	Standard error
(A) General fiber knowledge		
Constant	-0.350**	0.178
North Central	-0.110	0.085
South	-0.064	0.080
West	0.003	0.090
Race	0.116	0.083
Hispanic	-0.072	0.108
Age	0.004**	0.002
Household size	-0.002	0.020
Education	-0.032	0.025
Rural	-0.089	0.063
Male meal planners	-0.180**	0.089
Smoke	-0.098	0.063
Program	0.202***	0.076
(B) Specific fiber knowledge		
Constant	-1.391***	0.188
North Central	0.243***	0.087
South	0.063	0.084
West	0.342***	0.093
Race	0.453***	0.089
Hispanic	-0.530***	0.117
Age	0.002	0.002
Household size	0.043**	0.021
Education	0.283***	0.026
Rural	-0.077	0.064
Male meal planners	-0.162*	0.093
Smoke	-0.197***	0.065
Program	-0.227***	0.082
(C) Fiber demand		
Constant	1.546***	0.191
North Central	-0.049	0.048
South	-0.041	0.041
West	-0.073	0.047
Race	-0.065	0.054
Hispanic	0.244***	0.061
Age	-0.001	0.001
Household size	-0.029**	0.014
Rural	0.132***	0.036
Male meal planners	0.336***	0.042
Program	-0.092	0.057
Income	-0.008	0.010
General fiber knowledge	1.462**	0.576
Specific fiber knowledge	0.836***	0.134

Note: * = Significant at the 0.10 level. ** = Significant at the 0.05 level.
*** = Significant at the 0.01 level.

participate in either of those programs, although they were found to have higher levels of general fiber knowledge (significant at the 1-percent level).

In summary, meal planners with a high probability of having general fiber knowledge tended to be older, female, and participate in either the WIC or Food Stamp programs. Meal planners with a high probability of having specific knowledge about fiber, however, tended to reside in the North Central or West, to be nonblack and non-Hispanic, to have larger families and more than a high school education, to be female, and to neither smoke nor participate in the WIC or Food Stamp programs.

The probabilities for the GFK and SFK equations were calculated for each respondent in the sample using the estimated probit equations reported in table 5. These calculated probabilities were then used as instruments in the estimation of the fiber demand equation. Six out of 13 independent variables in the fiber demand equation were statistically significant at the 10-percent level or greater. These variables are Hispanic, household size, whether or not the meal planner was a male, whether or not the meal planner lived in a rural location, GFK, and SFK. In addition, the Program variable was borderline significant at the 11-percent level. Both direct and indirect effects have been calculated for selected variables and are presented in table 6. These effects assume that all other variables are held constant at their mean levels. Direct effects are those that occur when a variable changes in the demand equation. Indirect effects are those that occur when a variable changes in either the general fiber knowledge equation or the specific fiber knowledge equation, and work through the GFK and/or SFK variables in the fiber demand equation. In other words, the variable under question, say, household size, can be changed in the specific and/or general fiber knowledge equations, with all other variables held at their mean levels. The calculated probability can then be substituted in the fiber demand equation and the indirect effect thus calculated. Total effects are the sum of the direct and indirect effects, holding all other variables constant. Note that some variables such as smoking can have only an indirect effect since this variable is not explicitly included in the fiber demand equation. These results will be referred to in the discussion of the fiber demand equation.

Both knowledge variables are statistically significant at the 1-percent level or higher. Hence, knowledge, whether in general or specific, has a positive influence on whether or not meal planners consume larger amounts of fiber.

The estimated signs of both the Hispanic and household size variables were somewhat surprising. While both of these variables were insignificant in the GFK equation, the Hispanic variable was negative and significant in the SFK equation and household size was positive and significant. In the fiber demand equation, however, the signs reverse. In the case of the Hispanic variable, it may be that Hispanic diets are naturally higher in fiber than that of other Americans, possibly for cultural reasons. Hence, the direct effect (from table 6) on fiber demand is 2.70 grams higher than average, while the indirect effects via the SFK and GFK variables are -1.51 and -0.41 grams, respectively. Hence, the total effect is that Hispanic meal planners ingested 0.78 grams more fiber per day than the average meal planner.

The household size variable is more troubling. It may be the case that while the meal planners of larger households are more aware of which foods contain more fiber than others, this knowledge is not put into practice. Since larger households contain more children, it might be possible that these household members do not like foods that are naturally high in fiber and, therefore, influence which foods are in the house. In any case, the direct effect of this variable in the demand equation is that as household size increased from 2 to 5 persons, fiber consumption of the meal planners declined 0.73 grams. The total effect, however, is -0.47 grams since the indirect effect through the SFK is positive and offsets the direct effect.

We hypothesized that male meal planners consume more fiber than females, because they eat more food (*Nationwide Food Consumption Survey 1987-88*). The estimated coefficient is consistent with this hypothesis. Indeed, table 6 indicates that male meal planners consumed 3.27 more grams of fiber per day than female meal planners. The indirect effect through the two knowledge variables, however, reduced the total effect to 1.82 grams. Likewise, meal planners living in rural areas ingested more fiber than their urban/suburban counterparts, about 1.03 grams relative to the average meal planner. This is offset, however, by the indirect effects of both the GFK and SFK variables, so that the total effect is that rural meal planners consumed 0.40 grams more of fiber per day than their urban/suburban counterparts.

The results for both the education and smoking variables are interesting since they do not appear directly in the fiber demand equation. Hence, their effects on fiber demand can be found only by calculating the indirect effect of both variables. As noted above, meal planners who smoked had a lower probability of having either general or specific knowledge about fiber, and table 6 shows that these meal planners ingested about 0.98 grams less than the average meal planner (perhaps due to nicotine suppressing the appetite). Likewise, education had a negative but insignificant effect on

Table 6--Changes in grams of fiber consumption due to changes in selected variables, 1989-90

Variable	Direct effect	Indirect effect GFK[1]	Indirect effect SFK[2]	Total effect
		Grams		
North Central	-0.39	-0.36	0.26	-0.49
West	.61	.09	.01	.71
Race	.10	.08	.16	.14
Hispanic	2.70	-.41	-1.51	.78
Age	.14	.22	.02	.10
Household size	.73	.05	.31	.47
Education[3]	---	.37	1.97	1.60
Rural	1.03	.38	.25	.40
Male meal planners	3.27	.91	.54	1.82
Smoke[3]	---	.44	.54	.98
Program	.80	1.09	.70	.41

[1]GFK is the abbreviation for general fiber knowledge.
[2]SFK is the abbreviation for specific fiber knowledge.
[3]Neither Education nor Smoke appears in the demand equation; thus these variables have no direct effect.

general fiber knowledge and a positive and statistically significant effect on specific fiber knowledge. Hence, the indirect effect of education is that meal planners who attended college tended to ingest 1.60 more grams of fiber per day than those who completed high school.

This study demonstrates a positive link between what meal planners know about fiber and their intake of fiber. Meal planners, however, consume only about half of the recommended levels of fiber each day. Meal planners who consume less fiber than average tend to be those who smoke, live in the West or the North Central States, live in large households, and participate in the WIC program and/or receive food stamps. Meal planners who consume more fiber than average are those who are male, have higher levels of education, are Hispanic, and live in rural areas.

Nutrition education programs need to target all meal planners in order to increase the consumption of fiber. The arrival of mandated nutrition labels in 1994 and increased efforts by Federal and State Governments and private groups to encourage people to eat healthier diets, however, should push Americans higher up on the nutrition learning curve and lead to increased fiber consumption that is closer to the level of fiber consumption recommended by the National Cancer Institute. These activities, coupled with food industry efforts to develop and market alternative food products of higher nutritional quality, will begin to pay dividends to all Americans in the form of healthier and longer lives. In turn, eating more healthfully should help drive down health care costs associated with nutrition-related diseases, an added advantage for all of us.

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Appendix I. Dietary Fiber: A Complex Carbohydrate

Sugar, fruit, vegetables, and breads are all sources of carbohydrates. In fact, all sugars and starches that we eat, as well as dietary fiber, are carbohydrates. Most carbohydrates are converted by the body into an essential substance: glucose, the main sugar in the blood and the body's basic fuel (*Nutrition and Your Health: Dietary Guidelines for Americans*).

There are two general types of carbohydrates: simple and complex. Simple carbohydrates are the familiar sugars contained in such products as nondiet sodas and candy, foods that are generally high in calories with little nutritional value. In contrast, most foods containing complex carbohydrates are loaded with nutritional extras. Compare, for example, a slice of whole wheat bread, which contains 130 calories, and a regular soda with 150 calories. In addition to carbohydrates, the bread contains valuable nutrients, such as protein, B vitamins, iron, and dietary fiber. The soda contains none of these nutritional benefits.

All dietary fibers have two things in common: They are found only in plant foods, and they are resistant to human digestive enzymes. While most other foods are digested and then absorbed as they pass through the small intestine, dietary fiber enters the large intestine relatively intact. This helps reduce symptoms of chronic constipation, diverticular disease, and some types of "irritable bowel."

Dietary fiber is divided into two basic groups, soluble and insoluble. Insoluble dietary fiber absorbs many times its weight in water, expanding in the intestine. This type of dietary fiber is found mainly in whole grains and on the outside of seeds, fruit, legumes, and other foods. This type of fiber is key in promoting more efficient elimination by increasing stool bulk, and it may alleviate some digestive disorders. It is also thought to play a role in prevention of colon cancer.

Soluble dietary fiber is found in fruit, vegetables, seeds, brown rice, barley, oats, and oat bran. It can help produce a softer stool, and it works to increase cholesterol excretion in the bowel (by binding bile acids) and preventing their reabsorption.

Appendix II: Advantages to a High-Fiber Diet

Americans have a long way to go before reaching the National Cancer Institute's most recommended intake of 20-30 grams of fiber per day to obtain the full advantages of a high-fiber diet, since they currently consume about 10-13 grams per day. And this is in spite of how much has been written concerning the link between dietary fiber consumption and health. Elevated blood cholesterol levels are known to be one of the chief risk factors in heart disease, and a number of studies have linked diets high in soluble fiber with reduced blood cholesterol levels. Only soluble fiber may produce a significant reduction in blood cholesterol levels (the exact mechanism of this action, however, is not yet totally understood).

"Eating foods with fiber is important for proper bowel function and can reduce symptoms of chronic constipation, diverticular disease, and hemorrhoids," according to the *Nutrition and Your Health: Dietary Guidelines for Americans*. The guidelines suggest that diets low in dietary fiber may increase the risk of developing certain types of cancer.

Research on the link between dietary fiber and health is not sufficiently developed to associate a specific type of fiber or characteristic of fiber (such as particle size, chemical composition, or water-holding capacity) with reducing health risks. That is, the specific mechanism through which fiber works to reduce health risks has not yet been found. It is not clear whether the health benefits are due to fiber or to other substances in foods that contain fiber.

For these reasons, the new nutrition-labeling regulations require food labels that make health claims about dietary fiber intake to contain very specific language. The new food-labeling regulations set forth by the Nutrition Labeling and Education Act of 1990 specifically prohibit health claims relating fiber consumption to reduced risk for coronary heart disease and cancer. The new regulations do allow health claims relating diets low in fat and high in fiber-containing grain products, fruit, and vegetables to a reduced risk of cancer and/or coronary heart disease.