Consumer Awareness of Diet-Disease Relationships and Dietary Behavior: The Case of Dietary Fat

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Abstract. *We use FDA surveys on awareness of diet-disease relationships to estimate a probability model of awareness We apply the model to respondents of USDA's 1985-88 food consumption surveys to estimate a predicted probability of awareness, an explanatory variable in the multivariate analysis of fat intake Despite systematic changes in food behavior associated with diet-disease awareness, women with higher awareness probabilities showed no greater reduction in fat intake than others Difficulties in making effective food substitutions may be due to insufficient knowledge about the relative fat content of different food groups More research is needed to understand the complex link between diet-disease awareness and dietary practices*

Keywords. *Awareness of diet-disease relationships, fat intake, dietary practices*

Since the 1970's a consensus has emerged in the American public health community that changes in diet and other personal habits, such as exercise and smoking, can reduce the risk of such chronic diseases as cancer, heart disease, stroke, and hypertension (National Research Council, 1989 and 1991, U S Department of Health and Human Services, 1988) As a result, nutrition information and education activities in the United States have shifted from efforts to eliminate nutrient deficiency diseases, such as rickets and pellagra, to efforts to reduce chronic disease risks associated with overconsumption of fat, saturated fat, cholesterol, and sodium, and inadequate consumption of dietary fiber

The effectiveness of informing the public as a means of altering dietary patterns has been judged by examining changes in public awareness of diet-disease relationships and trends in per capita food consumption of specific commodities (like beef, whole milk, and fresh vegetables) (Levy and Heimbach, 1989, National Research Council, 1989 and 1991, Putnam and Allshouse, 1991, Schucker and others, 1987, Shekelle and Liu, 1978)

This article examines whether individuals more likely to be aware of a diet-disease relationship are more likely to alter their food choices to achieve dietary objectives Specifically, we examine how women more likely to be aware of the relationship between dietary fat consumption and the risks of contracting coronary heart disease and certain types of cancer alter their food consumption behavior And, if altered, do these changes in food consumption lower their intake of fat, saturated fat, and cholesterol, relative to other women who are less likely to be aware of the diet-disease relationship

Between 1977 and 1985, awareness of the link between fat intake and coronary heart disease increased on the order of 200-250 percent (Putler and Frazao, 1991) Although all segments of society experienced increases in awareness during this time period, the rate of increase varied greatly for different demographic groups Shekelle and Liu (1978) indicate that there was little, if any, variation in the level of awareness across different demographic groups in 1977 However, Schucker and others (1987) report that by the mid-1980's less educated, nonwhite, and low-income individuals had substantially lower awareness levels compared with other groups in society

Comparing the dietary changes of groups with the greatest increases in awareness with those experienced by other groups indicates the effect of awareness on dietary behavior Harris and Welsh (1989) and Putler and Frazao (1991) relate proxies for diet-health awareness to a total diet measure, the percentage of calories obtained from fat The findings of both studies suggest that women with higher awareness levels have made the greatest changes in their food choice behavior [1] However, changes in total fat intake levels were essentially uniform across different demographic groups Consequently, groups of women with higher levels of awareness were no more successful at lowering

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[1] Putler and Frazao (1991) explicitly argue that differences in dietary behavior across demographic groups can be used to indicate the effects of increased levels of diet-disease awareness However, Harris and Welsh (1989) do not make this argument

total fat intake than groups of women with lower awareness levels [2]

At the time of this study, no data set was available that measured whether an individual was aware of specific diet-disease relationships and simultaneously measured his or her actual food consumption behavior [3] However, several surveys of either diet-disease awareness or dietary behavior have been conducted since the mid-1980's The U S Food and Drug Administration (FDA) conducts the Health and Diet Surveys (HDS) to track the public's awareness and knowledge of diet and health issues The U S Department of Agriculture's Human Nutrition Information Service conducts surveys of individual food consumption and nutrient intake The food consumption and nutrient intake data used in this study are from the 1985 and 1986 Continuing Survey of Food Intakes by Individuals (CSFII) and the 1987-88 Nationwide Food Consumption Survey (NFCS)

We combine awareness and food consumption data by utilizing the strong demographic patterns that exist in the awareness of the link between fat intake and chronic disease Specifically, we use the FDA-HDS data to estimate a probability model of awareness, using survey participants' demographic characteristics as explanatory variables The fitted probability model is then coupled with the demographic characteristics of individual respondents in the food intake surveys to predict a probability of awareness for each respondent The more likely it is that an individual consumer is aware of the link between fat intake and chronic disease, the more likely that consumer is to alter food consumption behavior in an attempt to lower intake of fat, saturated fat, and cholesterol Although the fitted probability of awareness is an indirect measure, it is closely and directly tied to actual awareness As a result, it should be strongly indicative of the effects of diet-disease awareness on food consumption behavior

[2]Harris and Welsh's (1989) study is based on differences in dietary behavior across different income groups Putler and Frazao's (1991) study controls for a number of additional factors using multivariate statistical analysis Another study that indirectly measures the effects of awareness on dietary behavior is Ippolito and Mathios (1989) The study examined the effect on fiber cereal consumption of Kellogg's advertising and labeling of All Bran and Bran Flakes to convey the reduced cancer risk benefits associated with higher levels of fiber consumption

[3]A new group of surveys, the 1989, 1990, and 1991 Continuing Survey of Food Intakes by Individuals, conducted by the Human Nutrition Information Service (HNIS) of the U S Department of Agriculture, measures both diet-disease awareness and food consumption data for the same individual However, the first of these surveys (the 1989 survey) did not become available until late 1992

Demographic Differences in Diet-Disease Awareness

The HDS is a multi-instrument random digit dialing telephone survey of 3,200-4,000 individuals over the age of 18 residing in the 48 contiguous States The survey has been conducted roughly once every 2 years since 1982 The survey tracks consumer awareness of the link between the consumption of certain nutrients and chronic diseases, and attempts to assess usage and understanding of food labeling information, general nutrition knowledge and understanding, and self-reported dieting

Since 1983-84, the HDS has included a pair of unaided recall questions to elicit whether a consumer is aware of the link between dietary fat consumption and chronic disease [4] The first question is

> "Another thing found in many foods is *fat* Have you heard about any health problems that might be related to how much *fat* people consume?"

Respondents who answer "yes" to this question are then asked,

> "What health problems might be related to how much fat people consume? Are there any other health problems that might be related to how much fat people consume?"

The second part of this question is repeated until the respondent can no longer name additional disease conditions [5]

In our analysis, a respondent was considered as being aware of health problems associated with high fat intake if he or she responded with coronary heart disease, vascular diseases, or cancer Nearly all respondents who indicate that fat consumption was linked to health problems responded with at least one of these diseases

Awareness Trends

Figure 1 shows the percentage of the usable sample that reported that fat consumption was linked to coronary or vascular diseases or cancer Awareness is at a relatively high level, about 75 percent, with little change in overall awareness between 1986 and 1988 This suggests that diet-disease awareness had peaked by 1986

[4]The 1983-84 HDS began data collection in December of 1983 and concluded the collection in January of 1984

[5]The typical respondent can name one or two different diseases

Figure 1

Proportion of sample aware of diet-disease relationship

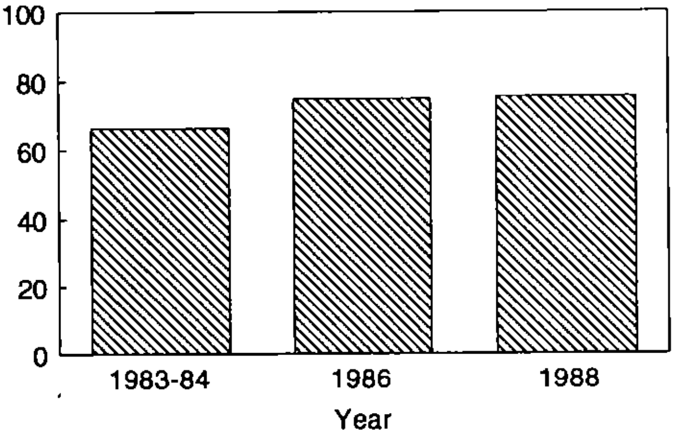
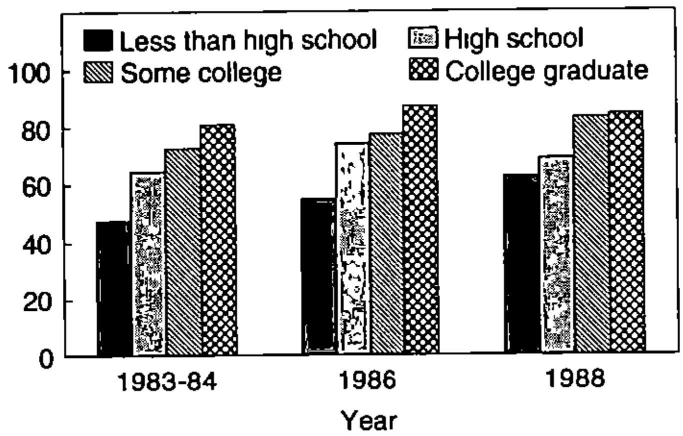


Figure 2

Differences in awareness, by education level



Despite the high awareness levels of the link between fat intake and chronic disease, there are strong differences in awareness levels across demographic groups For example, individuals with higher education levels are more likely to be aware of the link between fat intake and chronic diseases than are individuals with lower levels of formal education (fig 2)

Measuring Awareness

Demographic characteristics are hypothesized to influence the probability that an individual is aware of the link between fat intake and chronic disease Due to the discrete nature of our awareness measure—an individual is either aware or not aware—a logit probability model is chosen for estimation purposes [6]

The variables used in the logit analysis are those demographic factors believed to influence differences in both access to diet-disease information and concern for personal health Only demographic factors that are measured in both the HDS and the individual food intake surveys are used Demographic factors relate to age, race, sex[7], years of schooling, income level, and smoking status (yes or no) for each respondent (table 1)

Previous surveys (Food Marketing Institute, 1990, Gallup, 1990) indicate that men are typically less interested in diet and health issues than are women As a result, they are probably less likely to seek out and pay attention to information on diet-disease relationships, and, consequently, are less likely to be aware of these relationships

Racial differences were expected to influence diet-disease awareness because of differences in media habits among different racial groups For example blacks have lower newspaper and magazine readership rates than do non-Hispanic whites (U S Department of Health and Human Services, 1992) Since newspapers and magazines are the primary way that diet-disease information has been conveyed to consumers (Gallup, 1990), it is likely that blacks have lower awareness levels For similar reasons, coupled with lower levels of English language fluency, we anticipated that both Hispanics and the "other" race category, primarily Asians and Native Americans, would have lower levels of diet-disease awareness compared with non-Hispanic whites

Table 1—Explanatory variables and expected signs in the logit analysis of awareness

Variable	Expected sign
Age	+
Age-squared	–
Male	–
Non-Hispanic black	–
Hispanic	–
Non-Hispanic other race	–
Some high school	+
High school graduate	+
Some college	+
College graduate	+
Post graduate	+
Income residual	+
Income not reported	–
Smoker	–

[6]Maddala (1983) shows that logit and probit models yield very similar estimation results The logit model is used in this analysis because it is computationally less burdensome when used to predict probabilities

[7]Although we were interested in modeling awareness among women, data on men were included to increase the sample size

Some of the differences in readership rates may be due to differences in education levels For example, the number of media items read increases with years of formal education (U S Department of Health and Human Services, 1992) As a result, it is hypothesized that access to diet-disease information will be higher among individuals with education above the elementary school level, moreover, the size of the effects increases with higher levels of formal education

Given the almost universal awareness of the adverse health effects of smoking, one's choice to smoke provides an indication of how likely health concerns are to alter one's behavior A smoker is likely to place a lower value on their own health than a demographically similar nonsmoker, and, consequently, is less likely to seek out or pay attention to information related to health, including information on diet-disease relationships

Age and the square of age are included since it seems likely that beyond the age of 18 the probability of awareness would first rise, reach a peak, and then begin to decline The effects of income on the probability of awareness are captured using two variables In each year, roughly 15 percent of the survey respondents did not answer the question on their household income level In addition to greatly reducing the sample size, omitting these respondents from the survey increases the probability that the remaining sample suffers from self-selection bias In particular, it may be that individuals who refused to answer the income question may be less interested or less aware of the topics covered in the survey, and, therefore, less likely to be aware of diet-disease relationships As a result, nonrespondents to the household income question were kept in the estimation sample, and an indicator variable, income not reported, was included to control for their presence [8]

To capture the effects of income that are not captured by other demographic factors, residuals from estimated income equations were included in the final logit model These residuals were obtained from regression equations in which income was regressed on the remaining demographic factors The income residual is a proxy for a set of individual skills that are positively related to both household income level and the probability of diet-disease awareness, but that are not directly related to other included demographic factors

[8]Nonresponse rates to the household income question in the HDS were similar to the non-response rates for the respondents to the individual food intake surveys

Separate logit models were estimated for each of the three HDS surveys with similar results Thus, the 1986 and 1988 samples were combined in the final logit model to increase the reliability of the estimated coefficients (table 2)

Results

The model correctly classifies 76 4 percent of the respondents, and the likelihood-ratio test of the hypothesis that all model coefficients except the intercept can be set equal to zero is rejected with a very high level of confidence ($\chi^2_{(14\ df)}$ = 170 97, p < 0 00001) The signs of all the explanatory variables (excluding the intercept) are as anticipated, and significant The coefficients on the education variables increase as years of formal schooling increase The coefficients on age and the square of age indicate that the probability of awareness peaks at about age 50 and then begins to decline Finally, results suggest little difference in the probability of awareness between nonsmokers and smokers and between non-Hispanic whites and individuals in the "other" race category

The probability that an individual is aware of the link between dietary fats and chronic disease varies significantly with age, sex, education level, race, and income Furthermore, the probability that an individual is aware of this information can be predicted with a reasonably high degree of accuracy based on their demographic profile Thus,

Table 2—Estimation results for the diet-disease awareness model based on the 1986 and 1988 FDA-HDS data

Variable	Coefficient	Asymptotic T-Ratio
Age	0 1095	5 586*
Age-squared	- 0010	-5 206*
Male	- 4899	-3 928*
Non-Hispanic black	- 9245	-4 898*
Hispanic	- 4779	-1 601
Non-Hispanic other race	- 1867	- 641
Some high school	4321	1 528
High school graduate	8502	3 325*
Some college	1 4144	5 167*
College graduate	1 6440	5 570*
Post graduate	1 8526	5 259*
Income residual	0132	2 949**
Income not reported	- 3012	-1 785***
Smoker	- 1600	-1 193
Intercept	-1 9676	-3 875*
Percent correct prediction	76 4%	
Log of the likelihood function	-855 97	
χ^2, 15 degrees of freedom	170 97*	
N	1692	

*p < 0 001
**p < 0 01
***p < 0 10

the demographic profiles of the respondents to the food intake surveys may be used to predict an individual's probability of diet-disease awareness, and, in turn, this estimated probability may be used as an explanatory variable in analyses of food consumption behavior

Diet-Disease Awareness and Food Group Consumption Behavior

The 1985 and 1986 CSFII and the 1987-88 NFCS provide detailed information on an individual's food consumption and nutrient intake based on the foods he or she consumed over a 24-hour period All the surveys are based on independent samples drawn from the 48 contiguous States In each survey, demographic information on household members is collected through a personal interview (U S Department of Agriculture, 1985 and 1991) Although the intent and many practical aspects of the two types of surveys are nearly identical, there are some important methodological differences between the CSFII and the NFCS

The core sample for both the 1985 and 1986 CSFII are women aged 19-50 and their children aged 1-5 [9] The surveys were initiated in April of each year, and consisted of six waves over a 12-month period Food consumption data were collected for each respondent using a 24-hour dietary recall in each wave [10] The first day of food consumption data (the first wave) was collected using a personal interview Subsequent days of data were collected by telephone at approximately 2-month intervals Individuals in households without telephones were contacted in person (U S Department of Agriculture, 1985)

The sample for the 1987-88 NFCS includes all individuals, regardless of sex or age Food consumption and nutrient intake data were collected from each respondent over 3 successive days The first day of data was obtained using a 24-hour dietary recall administered through a personal interview The subsequent 2 days of data were obtained using a food intake diary completed by the respondent (U S Department of Agriculture, 1991)

The 1987-88 NFCS had a sample response rate of approximately 35 percent As a result of this low response and the potential for bias, the Life Sciences Research Office (Life Sciences Research Office, 1991) recommended that the 1987-88 NFCS be used only in conjunction with other data, such as the 1985 and 1986 CSFII [11] Thus, the four samples (1985 CSFII, 1986 CSFII, 1987 NFCS, and 1988 NFCS) are analyzed separately and are not pooled in this report

The sample for this study was carefully selected to maximize comparability between the data sources and minimize the methodological differences between the surveys The following criteria were used in determining the final sample (1) individuals in the 1987-88 NFCS had to be women aged 19-50 for comparison with the 1985 and 1986 CSFII, (2) only food consumption data from the 24-hour dietary recall of the 1987-88 NFCS and the first wave of the 1985 and 1986 CSFII are used since both are based on the same collection methodology, (3) because the first wave of data for the 1985 and 1986 CSFII was collected in April-June, only data for April-August in each year of the 1987-88 NFCS are used in an effort to reduce the effects of seasonality on food consumption patterns, [12] (4) since the 1987-88 NFCS collected education levels for only the male and female household heads, the 1985 and 1986 CSFII sample included only women from households where the female head of household is also a respondent,[13] and (5) only women with complete data on food consumption and from households that reported the demographic information necessary to predict the probability of diet-disease awareness are included Based on these five criteria, the sample sizes are 1,346 women for 1985, 1,336 women for 1986, 448 women for 1987, and 705 women for 1988

Food Groups

The number of distinct food items eaten by American consumers on any given day is incredibly diverse The women in each sample ate thousands

[9]In addition to this core sample, other population subgroups are surveyed The 1985 CSFII also contained a sample of under 1,000 men aged 19-50 Men were not surveyed in the 1986 CSFII

[10]In a 24-hour dietary recall, an interviewer elicits from each individual the kinds and amounts of each food eaten over the last 24 hours In the 1985 and 1986 CSFII and the 1987-88 NFCS, interviewers used a food instruction booklet to help respondents adequately describe foods eaten In addition, interviewers used standard household measuring cups and spoons and a ruler to help respondents estimate quantities of foods and beverages consumed

[11]It is generally believed that none of these past surveys suffers from nonresponse bias

[12]The 1987-88 NFCS sample included women interviewed from June to August in order to ensure an acceptable number of observations

[13]In the 1985 and 1986 CSFII, the education level of the women included in the sample was collected from each household Consequently, the education level of the female household head is available only for households where she is a respondent Since the education level of only the female household head was available in the 1987-88 NFCS, the fitted probability of awareness actually pertains to the female head of household and not necessarily the respondent However, approximately 90 percent of the sample are female household heads

of different food items, which are aggregated into a manageable number of groups for this analysis Forming food groups is always somewhat arbitrary since there is no single correct way of grouping different food items However, a great deal of thought was given to how and when foods are used in an effort to keep similarly used food items within the same grouping In addition, some foods that have been placed into a single food group in past studies, such as red meats, poultry, and fish (Harris and Welsh, 1989, U S Department of Agriculture, 1985 and 1987), are disaggregated into smaller groups due to likely differences in consumer perceptions about different items within the historically used food group All food items mentioned in the dietary recall data are aggregated into 11 exhaustive food groups (see appendix)

Food mixtures, such as sandwiches and casseroles, are not broken down into their individual ingredients, but are assigned to a food group based on the primary ingredient Thus, a hamburger with a bun is included in the "red meats" food group, while spaghetti with meat sauce is included in the "legumes and starches" food groups since spaghetti is the mixture's main ingredient The primary reason for assigning food mixtures to a single food category based on its primary ingredient, rather than breaking the mixture up into its constituent ingredients, is that individuals frequently make choices over different food mixtures, not over individual ingredients For example, an individual chooses to eat a slice of pizza, not the cheese, flour, tomato sauce, and other ingredients that make up the slice of pizza In studying food consumption behavior, we believe it is more appropriate to analyze food choices in the form that the foods are eaten

Sources of Dietary Fat

Table 3 gives the average share of total fat provided by each of the 11 food groups based on the combined samples of the 1985 and 1986 CSFII, and the 1987 and 1988 portions of the 1987-88 NFCS Red meats, dairy products, and food fats, dressings, and sauces are the three main sources of dietary fat, accounting for over half of all fat intake, on average The next four food groups (poultry, fish, and seafood, baked and frozen desserts, legumes and starches, and cereals, breads, and pastries) together contribute an additional 30 percent to total fat intake Salty snacks, nuts, and peanut butter, eggs and egg dishes, fruits and vegetables, and soups, beverages, and sweeteners contribute the remaining 20 percent of average total fat intake

Table 3—Weighted average distribution of total fat intake among the 11 food groups

Food Group	Percent of total fat intake
Red meats	24 41
Dairy products	16 32
Food fats, dressings, and sauces	12 28
Poultry, fish, and seafood	8 89
Baked and frozen desserts	8 43
Legumes and starches	7 79
Cereals, breads, and pastries	6 82
Salty snacks, nuts, and peanut butter	5 73
Eggs and egg dishes	4 06
Fruits and vegetables	3 50
Soups, beverages, and sweeteners	1 78

Source Combined sample of the 1985 and 1986 CSFII and the 1987-88 NFCS (n=3,835)

The share of total fat from the five food groups principally responsible for providing dietary fat varies across quartiles of diet-disease awareness probabilities (fig 3-7) Increases in the probability of diet-disease awareness are strongly associated with a lower share of fat from red meats (fig 3), but tend to be associated with higher shares of fat from food fats, dressings, and sauces (fig 5), and baked and frozen desserts (fig 7) There is no apparent relationship between the probability of diet-disease awareness and the share of total fat from dairy products (fig 4) or from poultry, fish, and seafood (fig 6)

To confirm that the effect of the estimated probability of awareness on diet changes is really due to diet-disease awareness and not due to some underlying demographic characteristic, figure 3 for red meats includes information from the 1977-78 NFCS (U S Department of Agriculture, 1983)[14], a time period when diet-disease awareness levels were low (Shekelle and Liu, 1978) Thus, a fitted probability of awareness would not be indicative of differences in diet-disease awareness levels in 1977, but an indicator of underlying demographic differences Figure 3 reveals strong and systematic differences in the share of fat from red meats across awareness quartiles for 1985-1988, but does not show any appreciable differences in 1977 Consequently, it appears that the estimated probability of awareness is capturing the effects of diet-disease awareness, and not underlying demographic differences Moreover, figure 3 suggests that increases in diet-disease awareness have had a measurable impact on women's food choices

[14]Red meats are chosen because this food group is the primary dietary source of fat and because it shows the greatest differences across awareness quartiles

Figure 3
Share of fat from red meats, sausages, and cold cuts, by awareness level

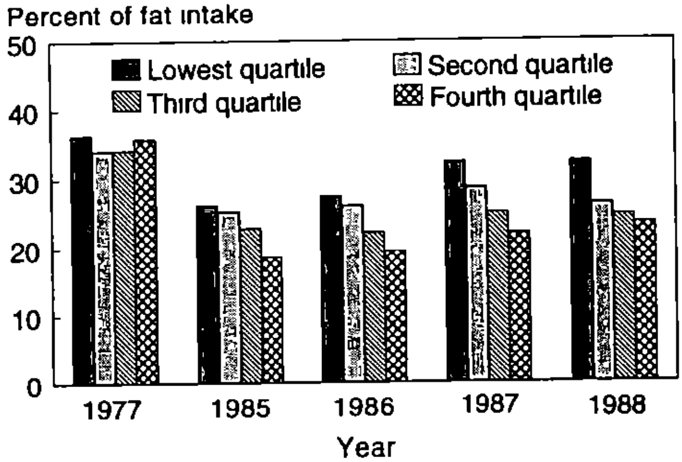


Figure 4
Share of fat from dairy products, by awareness level

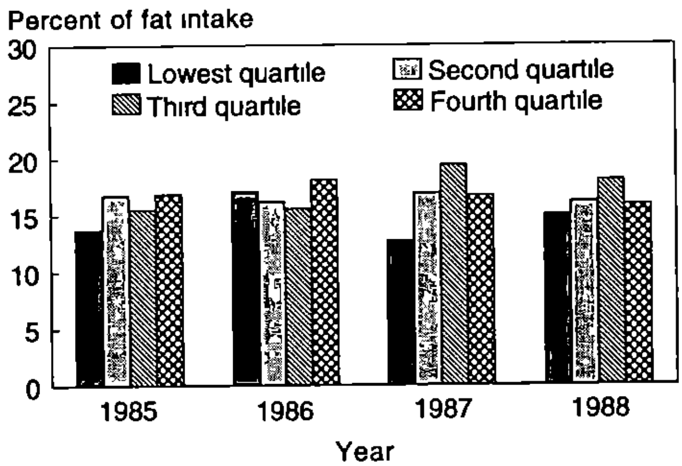


Figure 5
Share of fat from food fats, dressings, and sauces, by awareness level

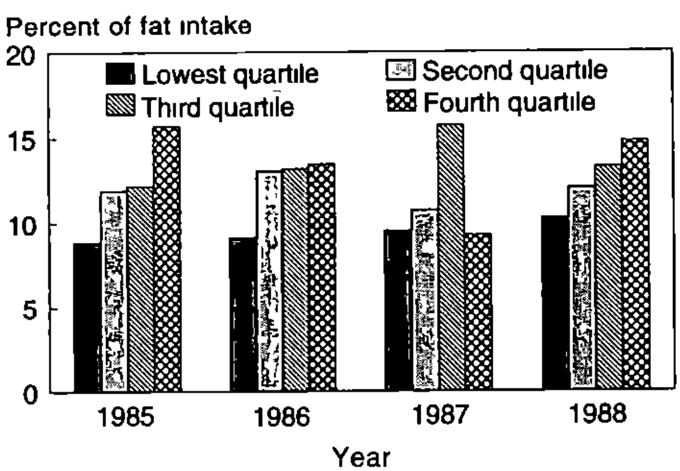


Figure 6
Share of fat from poultry, fish, and seafood, by awareness level

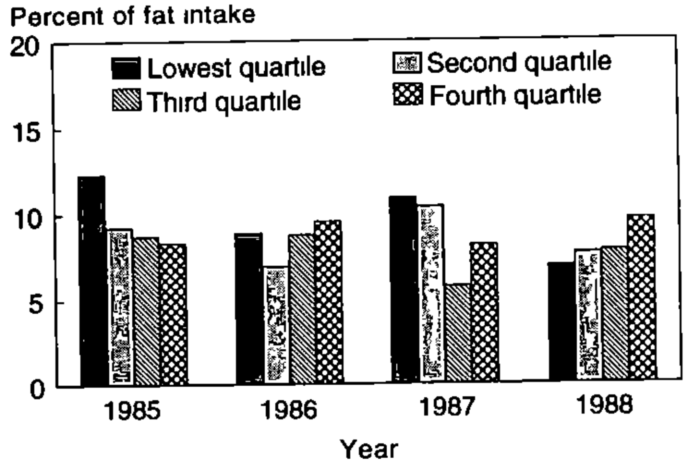
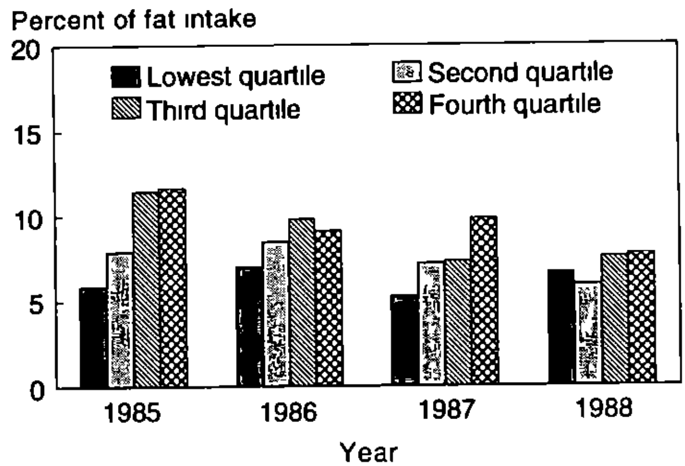


Figure 7
Share of fat from frozen and baked desserts, by awareness level



Multivariate Statistical Analyses of the Food Sources of Dietary Fat

Survey data revealed that a sizable proportion of women in each sample did not consume any items from a particular group As a result, a limited dependent variable estimation procedure is used instead of classical least-squares regression Three different estimation procedures are used one-limit tobit, probit, and truncated normal maximum likelihood estimation (Maddala, 1983) [15] We choose to use the three different procedures since each addresses a different question Probit provides an analysis of the probability that an individual consumed any items from a given food group Truncated normal maximum likelihood estimation

[15]Together, the probit and truncated normal maximum likelihood constitute one variant of the "Cragg" model (Cragg, 1971)

(MLE) analyzes the importance of a food group as a source of dietary fat in an individual's diet, given that the individual ate at least one item from the food group The one-limit tobit uses a single equation to account for whether an individual consumed an item from a food group and the share of fat attributed to that food group

Although the one-limit tobit estimator has the advantage of addressing both questions at once, it assumes that a given explanatory variable has exactly the same influence in determining whether any item from a food group is consumed as it does on the relative importance of the food group in providing dietary fat if it is consumed[16] The combination of the probit and the truncated normal MLE allows an explanatory variable to have a different effect on the choice of whether to consume from a food group than it does on the importance of the food group in providing dietary fat, given that items from the group are consumed However, the ability to allow the effect of an explanatory variable to vary across the two measures comes at the cost of assuming that the choice of whether to consume items from a food group is independent of the importance of that group in providing dietary fat given that it is consumed[17]

Past research on food consumption indicates that demographic and other characteristics have a strong influence on behavior (Cox and Wohlgenant, 1986, Haines, Guilkey, and Popkin, 1988, Lee and Phillips, 1971, Popkin, Guilkey, and Haines, 1989, Putler and Frazao, 1991, West and Price, 1976) These studies demonstrate the importance of biological factors (such as a woman's age, weight, and whether she is pregnant or lactating), special dietary behavior, race and ethnicity, residence (urban/suburban/rural and region of the country), household structure, financial resource level, employment patterns (is the female head employed), reported day (in the week) of intake data in explaining differences in food consumption patterns (table 4) Income is expressed as a percentage of the time-specific poverty level to partially control for both inflation and household size[18] The public assistance variable indicates whether a member of the household is currently enrolled in the Supplemental Feeding Program for Women, Infants, and Children (WIC) or receives food stamps Finally, the weekend variable indicates whether the 24-hour intake data from a respondent included a Saturday or Sunday

Because of the large number of estimated equations needed to analyze food group choices and dietary sources of fat, the complete set of estimation results are not presented here[19] Instead, tables 5 and 6 provide summaries of the results

Table 5 contains the number of times each of the explanatory variables is found to have a significant effect on the consumption of a food group for each of the estimation procedures A variable is defined to have a significant effect on a food group if it is statistically significant in at least two of the four samples with at least one of the significant coefficients falling in either the 1985 or 1986 sample[20] In addition, a variable has to have the same sign for a given estimation procedure and food group across the four different samples The same definition of significant effects is used in table 6

Table 5 results tend to confirm Haines, Guilkey, and Popkin's (1988) finding that the tobit estimation results tend to be more consistent with the probit results than with the truncated normal MLE results This suggests that the tobit models are primarily reflecting the decision to consume from a particular food group The fitted diet-disease probability appears to be one of the primary factors determining systematic differences in dietary behavior across individuals since it is significant more often than any other factor Moreover, diet-disease awareness has a relatively greater influence on the choice of whether to consume from a particular food group than it does on the importance of the food group in providing dietary fat, given that some item from the group is

[16]In a study of the effects of demographic factors on food consumption, Haines, Guilkey, and Popkin (1988) find that the tobit results are much more consistent with the probit results than with the truncated regression results As a result, they argue that the tobit procedure is primarily picking up the effects of the choice of whether or not to consume a particular food

[17]A generalized tobit procedure, also known as a type 2 tobit (Amemiya, 1985), has been developed that allows the explanatory variables to have differential effects on the two measures, and also accounts for the potential codependence between the measures It does this by assuming that the errors of the two measures are jointly and normally distributed Using this assumption, model parameters are estimated using maximum likelihood for the joint distribution However, the procedure has extremely poor convergence properties, and is computationally intensive since it requires double numerical integration over the parameters of a joint likelihood function The use of the generalized tobit was deemed infeasible for this study since it would require the use of the procedure in 44 separate instances (4 samples by 11 food groups)

[18]In a given year, the household income level needed to meet the poverty level varies with the size of the household

[19]For this portion of the study, 132 different equations were estimated (11 food groups by 4 samples by 3 estimation procedures) A complete set of results can be obtained from the authors upon request

[20]The requirement that a variable needs to be statistically significant in 1985 or 1986 is to lessen the possible effects of non-response bias associated with the 1987-88 NFCS

Table 4—Explanatory Variables and Sample Means

Variable	1985 (n=1,346)	1986 (n=1,336)	1987 (n=448)	1988 (n=705)
Awareness of the female head	0 77	0 78	0 76	0 78
Percentage of poverty	2 74	2 98	3 13	3 18
Public assistance (0,1)	12	09	14	11
Non-Hispanic black (0,1)	08	06	13	11
Hispanic (0,1)	05	04	06	06
Non-Hispanic other race (0,1)	03	03	04	02
Non-Hispanic white (Omitted)	84	87	77	81
Age	33 49	34 01	34 08	33 49
Weight	140 38	143 96	143 30	142 99
Pregnant/lactating (0,1)	04	03	06	05
On special diet (0,1)	12	14	08	10
Vegetarian (0,1)	03	02	02	03
Male head present (0,1)	73	75	75	76
Children present (0,1)	69	70	65	65
Female head employed (0,1)	61	61	62	68
Urban (0,1)	27	25	27	20
Suburban (0,1)	50	51	42	55
Rural (Omitted)	23	24	31	25
North-Central (0,1)	28	27	21	27
South (0,1)	33	32	43	35
West (0,1)	18	21	20	18
North East (Omitted)	21	20	16	20

Source 1985 and 1986 CSFII and 1987-88 NFCS

Table 5—Variables that significantly influence food choices and dietary sources of fat

	Number of times a variable has a significant effect*			
Variable	Tobit	Probit	Truncated normal MLE	Total
Awareness of the female head	5	6	1	12
Percentage of poverty	1	1	0	2
Public assistance	0	0	1	1
Non-Hispanic black	3	5	2	10
Hispanic	1	1	0	2
Non-Hispanic other race	5	2	0	7
Age	2	1	1	4
Weight	0	0	0	0
Pregnant/lactating	1	5	1	7
On special diet	3	4	1	8
Vegetarian	2	1	2	5
Male head present	2	0	0	2
Children present	0	0	0	0
Female head employed	0	1	0	1
Urban	0	0	0	0
Suburban	0	0	0	0
North-Central	1	1	1	3
South	3	1	1	5
West	0	0	0	0
Weekend	1	1	1	3

*The maximum number of times a variable could be significant for each estimation procedure is 11

consumed Finally, several factors other than diet-disease awareness have a strong influence on food choice behavior In particular, race and ethnicity, biological factors (age and whether a women is pregnant or lactating), special dietary practices (vegetarianism or whether a woman is on a special diet), and the region of the country in which a woman resides all have significant effects on food choices and the relative importance of different food groups in providing dietary fat

To gain an understanding of what effects diet-disease awareness has on food choices, table 6 contains a summary of the significance and signs of the fitted probability of awareness for each of the 11 food groups As the probability of diet-

Table 6—The effect of diet-disease awareness on specific food choices

Food group	Tobit	Probit	Truncated normal MLE
Red meat	–	–	NS
Dairy product	NS	NS	NS
Food fats, dressings, and sauces	NS	+	NS
Poultry and seafood	+	+	NS
Baked and frozen desserts	+	+	NS
Legumes and starches	NS	NS	NS
Cereals, breads, and pastries	NS	NS	NS
Salty snacks, nuts, and peanut butter	+	+	NS
Eggs and egg dishes	NS	NS	–
Fruits and vegetables	+	+	NS
Soups, beverages, and sweeteners	NS	NS	NS

disease awareness increases, the probability that a woman consumes red meats decreases, as does the relative importance of eggs and egg dishes in providing dietary fat, given that some item from this group is consumed Conversely, higher diet-disease awareness probabilities are associated with a greater likelihood of consuming food fats, dressings, and sauces, poultry, fish, and seafood, baked and frozen deserts, salty snacks and peanut butter, and fruits and vegetables Many of these findings are consistent with the notion that recent trends in aggregate per capita consumption (particularly the shift from red meats to poultry, fish, and seafood, and the increase in fruit and vegetable consumption) are at least partially due to increased consumer awareness of the links between diet and health (Levy and Heimbach, 1989, National Research Council, 1989 and 1991, Putnam and Allshouse, 1991)

It appears that informing the public about the link between fat consumption and chronic disease has motivated consumers to alter their dietary behavior Most of these changes seem to involve primarily the choice of whether to consume items from particular food groups on a given day However, it remains to be seen whether the food choices made by women most likely to be aware of the link between fat consumption and chronic disease result in lower levels of fat, saturated fat, and cholesterol intake compared with women less likely to be aware of this link

Diet-Disease Awareness and total Intake of Fats and Cholesterol

Current dietary recommendations (National Research Council, 1991, U S Department of Agriculture/U S Department of Health and Human Services, 1990) are based on intake levels of total and saturated fat measured as a percentage of total caloric intake, and cholesterol intake measured in milligrams [21] Consistent with these recommendations, we examine the effects of differences in diet-disease awareness probabilities on (1) the percentage of calories a woman obtains from all fats, (2) whether a woman has a total fat intake level no more than 30 percent of total caloric intake, (3) the percentage of calories a woman obtains from saturated fat, and (4) the milligrams of dietary cholesterol a woman consumes Two related but different measures of total fat intake are used because of the possibility that, although the average level of fat intake is approximately the same for different groups of women, one group may have a greater variance in total fat intake levels so that a higher percentage of women in that group are within the dietary guidelines

Differences in the Consumption of Fats and Cholesterol Across Awareness Probabilities

Figures 8-11 show how the four total intake measures for fat, saturated fat, and cholesterol vary over quartiles of the fitted probability of diet-disease awareness For both the average percentage of calories obtained from fat (fig 8) and saturated fat (fig 10), there are virtually no discernible differences across the probability of diet-disease awareness quartiles The average level of total fat is 36-39 percent of calories across all quartiles and samples, above dietary recommendations Similarly, the average level of saturated fat intake is 13-14 percent of calories across all quartiles and samples, above the recommendation that less than 10 percent of calories come from saturated fat

Although there is more variability in the percentage of women with total fat intake levels that meet dietary guidelines (fig 9), there is still no obvious relationship between this measure and the probability of diet-disease awareness

The lack of difference in total dietary intake measures between women more and less likely to be aware of diet-disease relationships may not indicate that information efforts have been ineffective It is possible that prior to the diffusion of information on the link between fat intake and

[21]Although the estimated awareness probabilities relate directly to fat and not cholesterol intake, individuals who are aware of one relationship typically are aware of the other Because of this, and because fats and dietary cholesterol tend to be discussed together in media reports on dietary risk factors for coronary heart disease, we have decided to include analyses of dietary cholesterol intake

Figure 8
Percentage of calories from fat, by awareness level

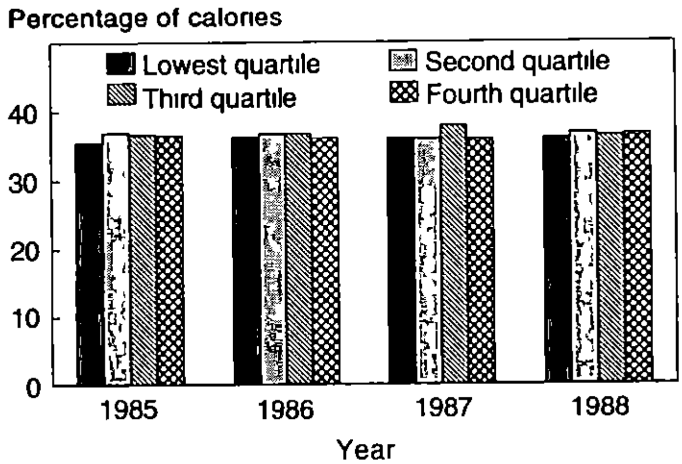


Figure 11
Average cholesterol intake, by awareness level

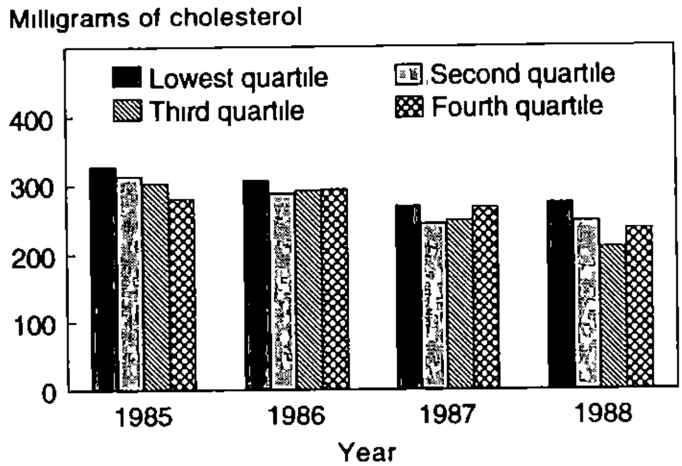


Figure 9
Proportion of women meeting dietary guidelines for fat, by awareness level

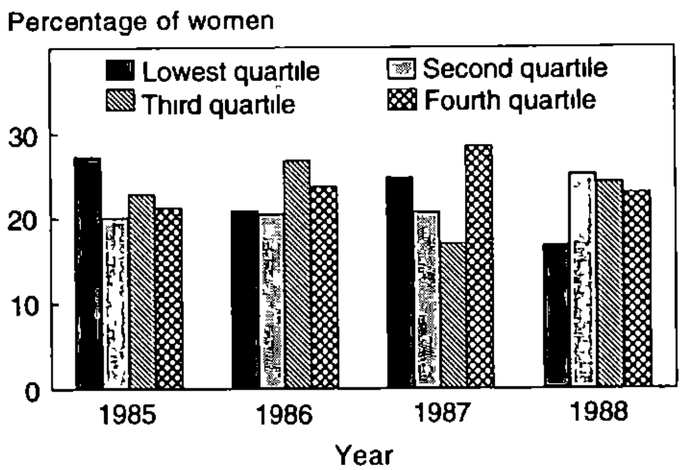
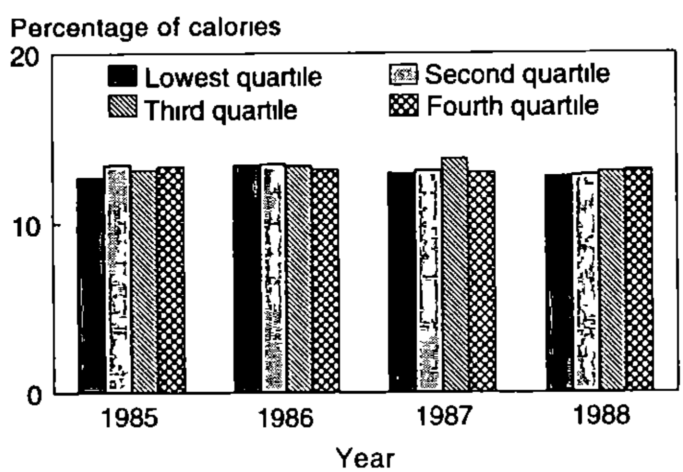


Figure 10
Percentage of calories from saturated fats, by awareness level



chronic disease, women with higher diet-disease awareness probabilities had diets higher in fat compared with women with lower probabilities of diet-disease awareness Then, informing the public about diet-disease relationships may have been at least partially effective in prompting desired dietary changes However, the findings of Putler and Frazao (1991) and Harris and Welsh (1989) indicate that in 1977, prior to the widespread diffusion of information on the link between fat intake and chronic disease, there were essentially no differences in total fat intake levels between women with high diet-disease awareness probabilities and women with low awareness probabilities In other words, it appears that, as a group, women with high diet-disease awareness probabilities have, on average, been no more effective in lowering their total intake of fats and cholesterol than groups of women less likely to be aware of this information

Multivariate Statistical Analyses of the Intake of Fats and Cholesterol

Multivariate statistical analyses of each of the four measures of total dietary intake were undertaken for two reasons (1) to determine if the effects of the fitted diet-disease awareness probability are being confounded with other demographic factors, and (2) to assess which, if any, demographic and other characteristics are associated with differences in total intakes of fats and dietary cholesterol The set of explanatory factors used in these analyses is the same as the set used to examine differences in food choices and dietary sources of fat (table 4)

Classical least-squares regression is used to examine the percentage of calories from both total and saturated fat, and intake level of cholesterol, while probit analysis is used to examine the probability that a women falls within the dietary guidelines for total fat consumption A so-called "log-odds" transformation (Pindyck and Rubinfeld, 1981) is used on the percentage of calories from both total and saturated fat [22] This transformation of the original dependent variable results in a new dependent variable that can take on any real value, rather than values that are bounded between zero and one As a result of this transformation, classical least-squares regression can be used rather than a limited-dependent variable estimation procedure such as the two-limit tobit Separate equations were estimated for each measure and sample Table 7 contains a summary of the significant estimation results [23]

Confirming the simple analyses based on quartiles of awareness, the multivariate statistical analyses indicate that the fitted probability of awareness does not have a significant effect on any of the four measures of fat and cholesterol consumption However, several demographic and other factors do have significant effects on total consumption of fats and cholesterol

One factor that seems to have a relatively large effect is race and ethnicity Both Hispanics and those in the "other" category (mostly Asians and Native Americans) have significantly lower intakes of both total and saturated fat than do non-Hispanic whites In addition, non-Hispanic blacks have, on average, significantly higher cholesterol intake levels than non-Hispanic whites Additional analysis reveals that non-Hispanic black women in the four samples have average diet-disease awareness probabilities considerably below non-Hispanic white women As a result, non-Hispanic blacks comprise a large percentage of the lowest probability of awareness quartile Consequently, the comparatively high cholesterol intake of the lowest awareness quartile in figure 11 is probably not a result of differences in diet-disease awareness, but rather of cultural differences between non-Hispanic blacks and other groups with respect to food preferences and choices

Other factors that have a major influence on total intake of fats and cholesterol are whether a women is following a medically or self-prescribed special diet and whether the reported day of dietary intake data falls on a weekend Women who follow a special diet have significantly lower intakes of total and saturated fat and are significantly more likely to have total fat intake levels that fall within the dietary guidelines On average, women who reported their diets for a day that fell on a weekend have significantly higher intakes of total fat and cholesterol and are less likely to have total fat intake levels that fall within the dietary guidelines, suggesting that people have a tendency to "let go" on weekends from a dietary perspective

Conclusion of Empirical Findings

Our analyses suggest that current efforts to inform the public about the link between fat intake and chronic disease have been effective in both making the public aware of these messages and motivating consumers to systematically alter their dietary behavior Women with higher probabilities of diet-disease awareness are less likely to consume red meats, and consume a smaller share of fat from eggs and egg dishes These women are also more likely to consume food fats, dressings, and sauces, poultry, fish, and seafood, baked and frozen desserts, salty snacks and peanut butter, and fruits and vegetables

Simply increasing the likelihood that a group of women is informed of the link between fat intake and chronic disease does not result in a reduction in consumption of total fat, saturated fat, or cholesterol, despite the systematic changes in food behavior associated with diet-disease awareness Although the data indicate that average fat intake has declined since 1977, those groups with higher diet-disease awareness showed no greater reduction in fat intake than others In other words, the larger dietary changes made by the group of women with higher diet-disease awareness probabilities had little net effect on their total fat intake relative to other groups of women Consumers may be having difficulties making effective food substitutions in their diets, perhaps due to insufficient knowledge about the relative fat content of different food groups

More research is needed to understand the complex link between diet-disease awareness and actual dietary practices With the availability of new data from HNIS's 1989-91 CSFII, which provide information on food consumption, diet-disease awareness, and specific nutrition knowledge, all for the same individual, it now becomes possible to evaluate the effect of diet-disease awareness on attitudes and specific nutrition knowledge, and, in turn, their effects on food consumption behavior

[22] The log-odds transformation is given by $\ln[P_i/(1-P_i)]$, where P_i is the percentage of calories obtained from either total or saturated fat for woman i

[23] A complete set of estimation results can be obtained from the authors upon request

Table 7—Variables that significantly influence intake of total fat, saturated fat, cholesterol, and the probability of meeting the dietary guideline for fat

Variable	Percentage of calories from fat	Probability of meeting dietary guideline	Percentage of calories from saturated fat	Milligrams of cholesterol
Awareness of the female head	NS[1]	NS	NS	NS
Percentage of poveerty	NS	NS	NS	NS
Public assistance	NS	NS	NS	NS
Non-Hispanic black	NS	NS	NS	+[2]
Hispanic	–[3]	NS	–	NS
Non-Hispanic other race	–	NS	–	NS
Age	NS	NS	NS	NS
Weight	NS	NS	NS	NS
Pregnant/lactating	NS	NS	NS	+
On special diet	–	+	–	NS
Vegetarian	NS	NS	NS	NS
Male head present	NS	NS	NS	NS
Children present	NS	NS	NS	NS
Female head employed	NS	NS	NS	NS
Urban	–	NS	NS	NS
Suburban	NS	NS	NS	NS
North-Central	NS	NS	NS	NS
South	NS	NS	NS	NS
West	NS	NS	NS	NS
Weekend	+	–	NS	+

[1]NS indicates the variable did not have a significant effect
[2]+ indicates the variable had a significant positive effect
[3]–imdcates the variable had a significant negative effect

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Appendix: Food Group Definitions

Red meats

Includes all separable cuts of beef, pork, lamb, veal, and game, all types of sausages, frankfurters, bacons, luncheon meats, and cold cuts, and food mixtures in which one of these meats or sausages (or a combination) represents a main ingredient (for example, hamburger on a bun, beef burritos, and pork chow mein)

Dairy products

Includes all types of fluid milk, cream and cream substitutes, yogurt (but not frozen yogurt), cheese, and food mixtures in which cheese is a main ingredient (for example, cheese pizza, meatless lasagna, and bean and cheese burrito)

Food fats, dressings, and sauces

Includes all types of oils, margarine, butter, salad dressings, and sauces

Poultry, fish, and seafood

Includes all separable pieces of chicken, turkey, duck, goose, cornish game hen, dove, quail, pheasant, fin-fish, and shellfish The group also includes food mixtures in which these meats represent a main ingredient (for example, chicken and tuna salad sandwiches, turkey pot pie, and sweet and sour shrimp)

Baked and frozen desserts

Includes all types of cakes, cookies, cobblers, pies, puddings, ice cream, ice milk, frozen yogurt, gelatin desserts, dessert toppings, and candy

Legumes and starches

Includes all food mixtures in which the main ingredient is a dry legume, pasta, rice, potato (except potato chips), other tubers, soyburgers, and plantains

Cereals, breads, and pastries

Includes all cold and hot breakfast cereals, flour, breads, rolls, muffins, pastries, bagels, doughnuts, pancakes, waffles, and tortillas

Salty snacks, nuts, and peanut butter

Includes crackers, pretzels, popcorn, chips, nuts, sunflower seeds, and peanut butter

Eggs and egg dishes

Includes eggs, omelets, and quiches

Fruits and vegetables

Includes all types of fresh, frozen, and canned fruits and vegetables, fruit and vegetable juices, and food mixtures where fruits or vegetables are the main ingredient

Soups, beverages, and sweeteners

Includes sugars and sugar substitutes, honey, jams, jellies, syrups, beverages (other than fruit and vegetable juices), and soups