June 1983 A.E. Res. 83-22

FACTORS AFFECTING NUTRIENT CONSUMPTION

by

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Introduction

The current issues regarding the adequacy of the American diet are no longer primarily associated with nutrient deficiency. Affluence, changes in lifestyle, and availability of highly processed foods have led to problems of overconsumption, primarily of fat, refined carbohydrates, and sodium. Overconsumption of these nutrients has been linked with many health problems now prevalent in the United States. Public health officials, nutritionists, policy makers, and consumers themselves are concerned with these trends and their implications for the future health of the nation[1].

The analysis summarized in this report attempts to determine the socioeconomic characteristics of the population that are related to overconsumption and dietary problems. Within this context, specific attention is given to the effect of consumption of food away from home on the quality of the diet. Regression analysis is used to model the relationship between socioeconomic characteristics of the individual, consumption of food away from home, and nutrient consumption.

Problems with Current Dietary Patterns

While total calorie consumption per person has not increased since the turn of the century, the composition of the American diet has changed considerably. As compared to the years 1909-13, the typical diet now includes more meat, poultry, fish, dairy products, fats, oils and refined sugar, as well as fewer eggs, potatoes, grain products, and fresh fruits and vegetables (Marston 1979).

These changes in food comsumption have altered the nutrient composition of the diet. In 1909-13, carbohydrate was the main source of calories in the diet, accounting for approximately 56% of total calories, while consumption of fat and protein accounted for 32% and 12% respectively. By 1979 fat consumption had increased to account for 42% of total calories, protein was constant at 12% and the share of carbohydrate had been reduced to 46% of the total (Marston 1980).

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[1] The authors are, respectively, graduate research assistant and assistant professor in the Department of Agricultural Economics, Cornell University. The research reported here is based on a M.S. Thesis by Karen L. Bunch, "An Analysis of Factors that Influence Nutrient Consumption" Dept. of Ag. Ec., Cornell Univ., Jan 1983.

The evidence suggests that these dietary trends are related to the increase in several major health problems. The two main health concerns and the leading causes of death in this country are cancer and heart disease. These diseases have been linked to overconsumption of several nutrients. Further evidence on the connection between diet and cancer has been recently released in a report by the National Cancer Institute (1982). After reviewing the results of years of research on the issue, the report confirms the prior findings that some foods and dietary patterns are related to higher incidence of cancer. Several specific recommendations to reduce the risk of cancer through changes in the diet are made by the review committee.

Fat consumption now comprises 42% of the total calories consumed in the United States. Overconsumption of fat has been determined to be a risk factor in heart disease, both directly and through the related problems of obesity, hypertension, and high serum cholesterol (Kurowski 1978). High fat diets have also been linked to a higher incidence of colon and breast cancer (Kurowski 1979). This link has been supported by the National Cancer Institute in their recent report (1982).

The other major dietary concern is the high percentage of refined sugar in the diet. Consumption of total carbohydrate has decreased since 1909, but in this total the percentage of refined carbohydrate has increased by 35% while the percentage of complex carbohydrate (whole grains and starch) declined by 50%.

In contrast to the overconsumption issue is the problem of nutrient deficiency. Over half of the school age children and pre-menopausal women in the country are estimated to be deficient in iron. Calcium consumption is also at lower levels for some groups (Halcrow 1978). The extent to which these deficiencies indicate a national health problem is hard to determine. The estimation of deficiency is based on the National Academy of Science Recommended Dietary Allowances for nutrients. Since the daily allowances are very generous in their estimation and the actual human needs for these nutrients are not yet known, the extent of the public health problem is unclear.

Aside from those of iron and calcium, nutrient deficiency in the United States is a problem only for a small minority of the population. Nutritional and food aid programs of the 1970's have been largely successful in dealing with of nutrient deficiencies. Clearly the principal nutritional problem of the 1980's can be redefined as one of over and not under consumption of nutrients.

Factors Contributing to Overconsumption

The trends in the American diet that have led to concern about the national health have been precipitated by the vast sociological changes that have occurred in the postwar period. There are several specific factors that have significantly affected our diets and our nutritional needs.

First, while per capita calorie consumption is roughly the same as it was seventy years ago, energy expenditure has decreased considerably. Mechanization, the shift from agricultural to service labor, and changes in our modes of transportation, have greatly reduced the number of calories typically utilized in one day. The chief causes of obesity are overeating and underactivity (Bogart 1973). The problem of obesity is apparent in this country where 20 percent of the population is "overweight to a degree that may interfere with optimal health and longevity" (U.S. Senate 1979).

Changes in family structure also have had an impact on the types of foods consumed. Families in which both partners work, smaller households, single parent households, and other non traditional structures, are becoming more common. The results are less time and concern over food preparation, and increased consumption of convenience foods and foods away from home.

Another factor related to the changing trends in nutrient consumption is the effect of media advertising on the food choices of the American public. Critics of food industry tactics argue that advertising of processed and unhealthful foods provides incomplete and misleading information that influence consumers to purchase foods that are nutritionally deficient and unhealthy (Gussaw 1978 and Robinson 1979). This has become a sensitive issue, particularly in regard to advertising directed at children. Their argument is supported by the fact that many people get the majority of their information on foods and nutrition from advertising, and that most foods advertised are high in the nutrients that are related to health problems in the United States (Halcrow 1977).

Consumption of Foods Away From Home

The increasing consumption of foods away from home in the United States is both a result of the changes in the American lifestyle over the last fifty years, and a factor affecting the quality of the diet. Americans have been spending an increasing percentage of their food dollar away from home. This percentage has increased from 20% in 1960 to over 42% in 1977 and is expected to reach 50% by 1985 (Mapes 1978). Of the total amount of money spent on food consumed away from home, 40% is spent at fast food restaurants (Ross Laboratories 1978). The increase in the consumption of fast foods parallels the dietary changes in the United States; fast foods are high in the nutrients that are being overconsumed in this country. There has been much debate over the quality of the typical fast food meal. Table 1 presents a nutrient breakdown for some of the meals typically served at the leading fast food chains.

Concern as to the impact of fast food on the quality of the diet center around two issues. The first concerns the nutrient density of the typical fast food meal. A low nutrient density indicates that the calorie content of the meal is high in comparison to the proportion of vitamins and minerals that it contributes to the diet. The typical meal will contain about one-third of the recommended daily requirement of vitamin C, half the requirement for protein, and one third the daily requirement for thiamin

Table I

Nutrient Content of Fast Food Meals

Place/Food	Total Calories	Protein (grams)	Carbohydrate (grams)	Fat (grams)	Vit A (IU)	Vit C (mg)	Iron (mg)	Calcium (mg)
Burger Chef ("Super Chef," fr. fries, choc. shake)	1300	47	181	41	773	24	5	661
McDonald's ("Big Mac," fr. fries, choc. shake)	1100	40	143	41	607	16	6	523
Burger King ("Whopper," fr. fries, choc. shake)	1200	40	147	47	650	29	7	439
Pizza Hut (10" pizza, cola drink)	1200	72	152	35	2000	2	14	1000
Kentucky Fried Chicken (3 pcs. chicken, roll, fr. fries, shake)	1300	65	141	57	750	27	5	150
Hardee's ("Formed" steak, bun, fr.fries, choc. shake)	1100	41	143	41	NA	NA	NA	NA
Arby's (Beef on bun, potato patties, coleslaw, shake)	1200	37	166	40	NA	NA	NA	NA
Arthur Treacher's (2 pcs. fish, fr. fries, cola)	900	22	101	42	NA	NA	NA	NA

SOURCE: Mapes (1978), Ross Laboratories (1978) and niacin. This is at a calorie content that is approximately half the daily requirement for the adult male. Other nutrients are present in smaller quantities, particularly iron, calcium, vitamin A and riboflavin. The amount of crude fiber contained in the meal is typically low. The fat content on the other hand is high for all meals, contributing a substantial percentage of the total calories. The sodium content in these meals is generally high.

Besides the nutrient content of these meals, the other major issue is the limited selection available in most fast food outlets. Nutritional adequacy has been found to be directly correlated to the variety and diversity of the diet. The trend towards greater consumption of fast foods reduces the variety of foods consumed and hence increases nutritional risk (McNutt and McNutt 1978).

The consumption of foods away from home varies greatly by age group. The largest consumers of fast foods are young adults. Utilizing the 1977 USDA food consumption survey, Guenther and Chandler analyzed food away from home consumption by age group. Of the total sample, 44% had consumed some food away from home on the day surveyed. This proportion is highest for males 23-34 years of age, 60% of whom consumed food away from home on the day surveyed. Among females, the highest proportion was 55% for the 12-14 year old age group.

It is clear from these figures that the younger generations are continuing the food consumption trends that began in the postwar era. If consumption of fast foods and foods away from home continues at the current rate, nutrition related health problems may increase. In a speech to the American Public Health Association, Dr. George Chistakis warned against creating a McDonald's generation. He argued that "allowing a youngster to join this generation can set the stage for chronic disease later in life. We must change our hamburger-malted way of life or change the content[2]"

Objectives of the Study

This paper addresses the issue of overconsumption in the United States, through analysis of how socioeconomic characteristics of the population are related to nutrient consumption.
Specific objectives of this study are:

1. Use regression analysis to estimate the relationship between nutrient consumption and socioeconomic characteristics of the individual and his or her household.

2. Determine the relationship between food away from home consumption and the quality of the diet by including a variable representing calories consumed away from home in the model of nutrient

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[2] Mapes (1978) as quoted from Yankelvitch,Skelly and White Inc. Nutrition: A Study of Consumer's Attitudes and Behavior Towards Eating at Home and Out of Home. Woman's Day Family Food Study, Feb. 1978.

consumption.

3. Estimate and interpret income elasticities for nutrients.

4. Compare the estimated nutrient consumption levels to the recommended daily allowances established by the National Science Institute to determine particular groups who may be at nutritional risk, in terms of both under and overconsumption.

5. Discuss the results of the regression analysis in terms of policy implications for improving the quality of the diets in the United States.

Description of the Data

The data utilized in this study are from the 1977 USDA Food Consumption Survey. The data set contains information on food and nutrient intake on one to three days for 9620 individuals interviewed in the spring of 1977. The survey also includes socioeconomic data on the individuals and their households.

Each household member present at the interview provided information on his or her food intake on the previous day. The household respondent was asked to provide information for children under twelve years of age. The interviewer then left forms for each household member to record his or her food intake for the current and following day. Forms were also left for individuals not present at the interview. The interviewer returned within three days to pick up the completed forms.

The method of collection can lead to potential bias in several ways. First the individual may not be able to remember accurately the types and quantities of food that he or she consumed on the day preceeding the interview. Second, given the forms on which to record food intake, the respondent may be careful to write down more of foods that he thinks the interviewer would consider acceptable, and not record other items.

Both these effects will lead to a downward bias in the reported quantities of foods consumed and therefore total nutrients consumed. This may be especially true for nutrients contained in foods commonly eaten for snacks. For some foods, such as fats and oils added in cooking or beverages (milk) there may be over reporting of the amounts consumed. In these instances the overall direction of the bias is indeterminant.

These biases are common for all data that contain information on food intake where the respondent is responsible for the accuracy. The effects and direction of this bias will be taken into account when interpreting the data and statistical results.

Nutrient Consumption

Nutrient values of food intakes of individuals were provided by the USDA as part of the survey data. These values were calculated from a special nutrient data base constructed from partially updated composition values of foods from USDA Agricultural Handbook No.8 (1968). Nutrient values for specialty foods or standardized food away from home (fast food) were obtained from industry sources (USDA 1980).

Table 2 presents the percent of the recommended daily allowances consumed by individuals classified by age and sex.

On the average, most classes reported consuming fewer calories than the RDA, particularly females 21-60 years of age. This is inconsistent with the figures on the prevalence of obesity in the United States. These low values for calorie consumption may be a result of bias due to the under reporting of food intake discussed earlier. It will be important to consider this bias in interpreting the results of the analysis. Protein consumption meets or exceeds the RDA for all ages and sexes as does vitamin C consumption. Iron and calcium consumption, however, fall short of the RDA for many groups. Children under 12 of both sexes were deficient in iron consumption as were adult women. Calcium consumption was marginally deficient for most all age groups, particularly females 6-21 years of age who had a significantly lower level of calcium consumption than their male peers.

Table 3 shows the percentage of calories from nutrient sources and food away from home. Males and females 40-60 years of age obtained a higher percentage of calories from fat than any other age group. All the age groups, however, exceed the dietary guideline recommendation of no more that 30% of total calories from fat. These guidelines are especially relevant for adults 40-60 years of age who are at higher risk because of the potential for diet related health problems.
The values for percentage of calories away from home are the average of all individuals including those who consumed no calories away from home. The highest percentage of calories away from home was consumed by young adults, 13-21 years of age. The percentage of calories away from home is lower for older adults, who consume fewer than 8 percent of total calories away from home.

Consumption of food away from home also varies with other characteristics of the sample, namely income, race, urbanization, and hours worked by the female head of the household. The percentage of calories consumed away from home for various levels of these characteraretics is presented in Table 4.

White individuals and those living in urban areas consume the largest amount of food away from home of all races and urbanizations. Surprisingly, the rural farm classification also has a high level of food away from home. This may be due to meals consumed at community events or homes of friends and not necessarily restaurants. As expected, food away from home consumption increases with income, reaching a peak at a household income of $25,000-49,000.

TABLE 2

Percentage of Recommended Daily Allowance Achieved by Individuals
Classified by Age and Sex

Years of Age	Kcal	Protein (gm)	Calcium (mg)	Iron (mg)	Vit A (IU)	Thim (mg)	Vit C (mg)
0-6							
Male	96	230	95	84	174	130	166
Female	94	159	86	76	164	116	156
7-12							
Male	81	192	79	124	123	108	150
Female	77	178	71	121	126	103	147
13-21							
Male	82	178	93	91	129	118	164
Female	75	157	66	64	113	114	133
22-40							
Male	89	175	102	160	107	105	145
Female	79	151	72	61	116	97	129
41-60							
Male	92	169	92	158	122	105	153
Female	75	148	65	62	134	104	140
61 +							
Male	81	144	89	147	149	118	170
Female	81	138	73	110	172	107	160

SOURCE: USDA 1977 Individual Food Consumption Survey:
Sub-sample 3919 Individuals

Table 3 shows the percentage of calories from nutrient sources and food away from home. Males and females 40-60 years of age obtained a higher percentage of calories from fat than any other age group. All the age groups, however, exceed the dietary guideline recommendation of no more that 30% of total calories from fat. These guidelines are especially relevant for adults 40-60 years of age who are in a higher risk because of the potential for diet related health problems.

TABLE 3.

Percentage of Calories from Nutrients and Food Away from Home

	Percentage of Calories From			
Years of Age	Protein	Fat	Carbo-hydrate	Food Away From Home
0-6				
Male	15.7	37.1	47.8	11.0
Female	15.8	36.6	48.0	10.7
7-12				
Male	15.6	38.2	47.0	20.1
Female	15.4	38.5	47.1	20.1
13-21				
Male	16.3	40.1	44.1	20.1
Female	16.5	40.1	43.8	20.8
22-40				
Male	16.5	42.0	39.9	21.8
Female	16.3	41.1	41.1	16.4
40-60				
Male	17.4	42.6	38.3	15.1
Female	18.7	42.0	39.9	11.9
61 +				
Male	16.8	41.3	41.8	8.9
Female	16.9	40.3	43.4	6.7

SOURCE: U.S.D.A. Individual Food Consumption Survey 1977: Subsample 3919 Individuals.

TABLE 4

Breakdown of Calories Away from Home by Socioeconomic Factors

Characteristic	% Calories Away From Home Mean	Standard Deviation
Race:		
White	16	20.2
Black	13	18.1
Other	13	17.3
Urbanization		
Urban	16	20.5
Rural Nonfarm	13	18.5
Rural Farm	16	18.4
Household Income ($000)		
0-5	12	17.2
6-9	14	19.5
10-24	16	19.6
25-49	20	20.5
50 +	17	17.8
Hours Worked by Female Head		
0	12	17.2
1-15	15	16.9
16-30	21	21.9
30-40	22	21.8
40 +	28	29.3

SOURCE: U.S.D.A. Individual Food Consumption Survey 1977: Subsample 3919 Individuals.

Food away from home consumption increases markedly as the number of hours worked by the female head of the household increases. Individuals who live in households where the female head works 16-40 hours per week consume 22% of total calories away from home. This percentage increases to 29% when the female head works more than 40 hours per week.

Specification of the Model of Nutrient Consumption

The purpose of this section is to describe the model that will be used to determine how specific socioeconomic characteristics are related to nutrient consumption. The socioeconomic variables in the model will be discussed and specified.

Specification of the Model

The model to be estimated is as follows:

$$Q_i = \alpha + \beta_1 \ln Y + \beta_2 Ed + \beta_3 W + \beta_4 S + \beta_5 Wt + \beta_6 F + \beta_7 U_1 + \beta_8 U_2 + \beta_9 R_1 + \beta_{10} R_2 + \beta_{11} A_1 + \beta_{12} A_2 + \beta_{13} A_3 + \beta_{14} A_5 + \beta_{15} A_6 + \beta_{16} Rg_1 + \beta_{17} Rg_2 + \beta_{18} Rg_3 + \beta_{19} Kah1 + \beta_{20} Kah2 + \beta_{21} Kah3 + \beta_{22} Kah4 + \beta_{23} Kah5 + \beta_{24} Kah6 + 1$$

The variables are as follows:

Dependent variables

Qi : consumption per individual per day of the following nutrients:

Q_1= calories
Q_2= protein (milligrams)
Q_3= fat (grams)
Q_4= carbohydrate (grams)
Q_5= calcium (milligrams)
Q_6= iron (milligrams)
Q_7= vitamin A (international units)
Q_8= thiamin (milligrams)
Q_9= vitamin C (milligrams)
Q_{10}= percentage of total calories from protein
Q_{11}= percentage of total calories from fat
Q_{12}= percentage of total calories from carbohydrate

Independent variables:

LnY: natural log of per capita income

Ed: years of education completed by the female head of household

W: employment of the female head of household

S: sex of individual

Wt: weight of individual

0/1 Classification Variables:

U: urbanization

U_0 rural farm

U_1 urban

U_2 rural non-farm

R: Race

R_0 white

R_1 Black

R_2 Other

A1-A6: age of individual

A1 0-6 years

A2 7-12 years

A3 12-21 years

A4 22-40 years

A5 40-60 years

A6 over 60 years

R: geographic region

Rg_0 Western region

Rg_1 Southeastern region

Rg_2 Midwestern region

Rg_3 North central region

Kah1-Kah6: percentage of total calories consumed away from home classified by each age group.

The nutrients were chosen for estimation based upon their importance in human nutrition and their relevance to current dietary issue[3]. The

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[3] Equations for sodium and refined carbohydrate were originally to be

three ratios, percentage of calories from protein, fat, and carbohydrate, are measures of the composition of the diet, and as such are relevant to current dietary problems as discussed in Chapter 1. Since these values are percentages, they express the consumption of protein, fat, and carbohydrates, on a scale relative to each individuals total consumption. Consequently, estimation of these equations will provide additional information about the relationship between socioeconomic characteristics and overconsumption.

The same variables are used to estimate consumption of each nutrient. Since nutrients are all components of food, it is not possible to hypothesize any specific relationship between a single nutrient and the socioeconomic variables defined.

The unit of observation for this model is the individual. This approach has an advantage over household data in that the foods and nutrients reported are consumed directly by the individual. In other words, the complex question of how total household food is allocated among the individual family members is avoided.

Some of the variables, however, are necessarily specified at the household level. It is hypothesized that household characteristics affect the types of foods available in the household, while the specific foods and quantities consumed are more directly determined by the characteristics of the individual. That is to say, income, education of the female head, etc. determine the types of foods and therefore nutrients purchased for the household. The characteristics of the individual are what determine which specific foods and the quantities that are consumed by the individual. Both sets of characteristics are related to the nutrient consumption of the individual. In this analysis then, it is more appropriate that both the characteristics of the household and those of the individual be taken into account.

Socioeconomic Characteristics

Income

The first concern in specifying the income variables is whether to utilize total household income or to deflate the value to a per capita basis. It was decided that it would be more consistent to use a per capita value in order to have income specified in the same terms as consumption. Family size is used as the value to deflate household income to a per capita basis. This is consistent with the approach of George and King (1971). Unit equivalent scales would not be appropriate for this analysis because, unlike studies of household consumption, the characteristics of the individual are included in the regression.

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estimated but the data were not available from the USDA in time for inclusion in the analysis.

Income is specified in the model in semi-logarithmic form for both theoretical and practical reasons. Previous studies (Prais and Houthakker, Rockwell) have determined that the semi- logarithmic form is the most appropriate for defining the relationship between income and food consumption. This functional form is characterized by an income level at which no food is consumed and by an increase to a satiation point at which consumption levels off. Using the 1965 USDA Food Consumption Survey, O'Brien (1979) has shown the semi-log from to be the most appropriate for the specification of the relationship between income and the comsumption of nutrients. For the present application, the model was tested for fit using the linear, quadratic, semi-logarithmic, and double-log form for income. Based on R squared and F ratio criteria the results support the use of the semi-log form as the most appropriate specification[4].

The relationship between income and the consumption of nutrients is hypothesized to be positive for all nutrients except carbohydrates. The relationship between income and carbohydrates is indeterminant in that two effects are involved. While increased income may result in reduced consumption of starchy foods, such as potatoes, macaroni, etc., it may be associated with an increase in the consumption of refined carbohydrates such as those contained in processed foods, candy, and alcohol. This specific relationship and the existence of a possible threshold effect or change in the slope of the function at higher income levels is examined more thoroughly in Bunch (1983).

Urbanization

Urbanization is included in the model as a proxy for lifestyle and the differing availability of foods between urban and rural areas. Burke (1961) studied the relationship between urbanization and food consumption. She specifies four factors that are related to variability in food consumption among urbanizations : (1) home production, (2) accessibility to different types of food, (3) prices of foods and non-food goods, (4) and social and cultural factors.

Three classes are specified: rural farm, rural non-farm, and urban. Using classification variables for rural non-farm and urban, rural farm is specified as the base class.

Individuals in the rural farm class are hypothesized to consume more of all nutrients holding all other factors constant. This is based on an expectation of different physiological need from the other classes and on the availability of home-produced food.

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[4] See Bunch, Karen "Analysis of Factors that Influence Nutrient Consumption' Masters thesis, Cornell University, January 1983, for more detail on this specification.

Race

Race is specified in the model in three classes: white, black, and other. White is designated as the base class. This variable is included in the model to account for variation in nutrient consumption due to ethnic influences on the types of food consumed.

Salathe et. al. (1979) studied the effect of race on food consumption. They found that black families spent more per capita per week on pork, poultry, and fish than did white households and significantly less on dairy products, fruits and vegetables. These differences in food consumption lead to the hypothesis that black individuals consume more thiamine and vitamin A than do white individuals, as these are the primary nutrients contained in those foods. It is also hypothesized that black households will have a significantly lower calcium intake than white households. No hypothesis is made concerning the consumption of individuals in the other race classification, because of the small number of observations and the diversity of races represented in this catagory.

Education of the Female Head of Household

Education is included in the model as a proxy for the effects of nutritional knowledge or ability to make appropriate food choices. Therefore, the value specified is the number of years of school attended by the female head of household. This is based on the assumption that the female head is most often responsible for the meal preparation and food purchasing for the household. If no female head was present in the household, the education of the male head was substituted.

Education is hypothesized to have a continuous relationship with nutrient consumption. The variable is specified in a linear form. The quadratic form was also tested but the linear form produced a higher R^2 and F ratio than the quadratic form.

Based on previous research by both O'Brien and Adrian and Daniel, one would expect a positive coefficient for the education variable in the equations for vitamin C, calcium, and iron. Increased education and thereby nutritional awareness should lead to an increase in the consumption of these nutrients. Based on the same logic one would expect a negative relationship between education and fat consumption to exist. No hypothesis regarding the signs of coefficients is advanced for the other nutrients.

Work

This variable is specified as the average number of hours worked per week by the female head of household. As with education this variable is specified as a continuous rather than a dummy variable. It is hypothesized to have an impact on the types of nutrients available to the individuals in the household. As the number of hours worked per week increases, the female head presumably has less time to shop and prepare meals and may have to rely more on processed foods or foods consumed away from home. Both the education and employment of the female head are included in the model as proxies for the opportunity cost of time. In the present specification the variable is hypothesized to be positive in the equations for calories, fat, and protein, and negatively related to consumption of thiamin, vitamin C, and calcium. These are nutrients which are not often available in foods consumed away from home. The effect on the other nutrients is indeterminant.

Family Size

Family size is included in the model to determine how changes in family size will affect individual nutrient consumption. Increased family size is hypothesized to have a positive effect on the quality of the diet once the effect of income is taken into account. The rationale for this hypothesis is that larger households will prepare more complete meals and have a greater selection of foods available. Conversely, it is thought that the single-person or small household will rely more on convenience foods, foods away from home, or skip meals altogether. Therefore a positive relationship is expected for the family size coefficient in the equations for calories, protein, iron, vitamin A, C, and thiamin. A positive relationship for calcium is also supported by the findings of a significant positive relationship between family size and consumption of dairy products, as discussed in the literature review (George and King).

Age

Age is included in the model to control for changing nutritional needs over the lifecycle and as a proxy for age-related food choices. The variable is specified in six classes: 0-6 years, 7-12 years, 12-21 years, 22-40 years, 41-60 years, and 60+ years. These levels were chosen to represent significantly different periods in the lifecycle and to be in accordance with the nutrional needs through the lifecycle as defined by the Recommended Daily Allowances (1980). In the model of nutrient consumption, age is represented by five zero-one classification variables: A1(0-6 years), A2(7-12 years), A3(13-21 years), A4(22-40 years), A5(41-60 years), A6(61+ years). Class A4 is designated as the base class.

Sex

Sex is included as a zero-one dummy variable with female utilized as the base class. Due to physiological differences in nutrient needs, it is expected that males will consume more of all nutrients than females and that this variable will be significant in all equations.

Weight

Weight is specified in pounds per individual. As with sex, it is included in the model to account for variation in nutrient consumption due to physiological need. Weight is hypothesized to be positively related to consumption of all nutrients.

Information on weight was supplied by the individuals during the interview. The weights of children and individuals absent during the interview were supplied by the head of the household. Weight is commonly included in nutritional studies as a determinant of size[5], rather than including height or both height and weight. In this sample weight and height are highly collinear. For this reason and because it accounted for a larger portion of the variance in nutrient consumption, weight alone is utilized as the indicator of size.

Region

Region is included in the model to account for interregional price differences as well as other regional factors such as lifestyle and food availability. Four regions are specified in the data: Northeast, Northcentral, South and West. The western region is designated as the base class. Based on the food consumption research of George and King, there is expected to be regional differences in the consumption of fats, protein, calcium, and vitamin C.

Calories Away from Home

The determination of the effect of foods consumed away from home on nutrient consumption and the quality of the diet is a focal point for this thesis. In the model, consumption of food away from home is specified as the percent of total calories consumed away from home. As a percentage value, it is similar to the diet composition values in that it represents the source of a certain percentage of the total calories consumed. Calories of food were chosen over grams as a more appropriate unit of comparison.

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[5] Personal conversation with C. Biondi, Associate Professor of Nutrition, Cornell University

Over all of the individuals in the sample, the percentage of calories consumed away from home ranges from 8% to 22% (Table 3.6). Most of this variation is associated with age groups. Therefore it was decided that the most appropriate specification for the food away from home value would be in terms of age. To specify food away from home consumption for each age group separately, each age classification variable (0/1 dummy variables) was multiplied by the food away from home variable. This resulted in 6 separate age/food away from home variables, Kah1-Kah6, where Kah1 contains only the calories away from home values for individuals between the ages of 0 and 6, etc.

In the data set, the sources of food away from home include restaurants, school, homes of friends, etc., any food not originally from home source. Therefore types of foods consumed away from home depend upon the location of the eating occasion (i.e. restaurant or school) and the type of meal, as well as other factors. It is hypothesized that these factors vary with age as does the percentage of calories consumed away from home.

As discussed in earlier in this paper, teenagers and young adults are the largest consumers of fast foods. Because of the types of nutrients typically contained in fast foods, it is hypothesized that for the 13-21 and 22-40 year age groups calories away from home will be positive in the equation for fat and percentage of calories from fat, and negative in the equations for calcium, iron, vitamin A, thiamine, and vitamin C. Because of the variation in the types of foods consumed away from home, for the other age groups it is difficult to hypothesize the direction of the relationship between calories away from home and the consumption of specific nutrients. Therefore no hypothesis is advanced.

Results

The model was estimated using ordinary least squares regression for the nine nutrient equations and three diet composition equations specified in the previous section. R^2 and F values for these regressions are presented in Table 5. The percentage of the variance in nutrient consumption explained by the independent variables (R^2) ranges from .30 to for protein to .06 for vitamin A. The F ratios for these regressions are all significant at the 5% level, allowing for rejection of the null hypotheses that the regression coefficients are equal to zero.

TABLE 5

R^2 and F Statistics for Two Nutrient Consumption Models

	R^2	F
Calories	.26	66.99
Protein	.30	67.73
Fat	.26	57.62
Carbohydrate	.21	42.36
Calcium	.19	36.63
Iron	.17	34.10
Vitamin A	.06	9.74
Vitamin C	.07	12.21
Thiamine	.18	35.83
Procal	.08	13.91
Carbcal	.14	25.32
Fatcal	.07	12.84

Classification Variables: Region, Race and Urbanization

Regression coefficients for these variables are presented in Table 6. As hypothesized, individuals in both urban and rural non-farm classes consume less of all nutrients than the rural farm classification. These relationships are significant for all nutrients except calcium.

There are also significant differences in nutrient consumption among races. According to the model's results, the diet of black individuals tends to be higher in protein and lower in fat than that of white individuals. As indicated by their food choices, blacks as a group also have lower consumption of calcium and higher consumption of vitamin A. The average consumption of vitamin C by blacks is significantly higher than either of the two other race classes.

The model predicts regional variation in consumption for all of the nutrients estimated. Holding all of the other variables constant, the western region consumes the highest level of all nutrients except thiamin, which is highest in the South, and vitamin C which is highest in the Northeast. These differences are all statistically significant. Diets in the southern region are consistently poorer than those of the Western region, particularly in the consumption of calcium, thiamin, and vitamin C. Diets in the South also contain relatively more carbohydrate and less fat or protein than diets of individuals in the Western region.

Table 6

Regression Results for Nutrient Consumption Models

Regression Coefficients
(Standard Error)

Nutrients	Intercept	Region: Northeast	Region: N Central	Region: South	Urban: Urban	Urban: Rural Nonfarm	Race: Black	Race: Other
Calories	1267.24	-46.04	-48.16	-83.06	-178.16	-165.41	-10.83	-33.78
	(97.03)	(32.17)	(31.39)	(30.87)	(47.83)	(49.18)	(31.83)	(50.87)
Protein	53.22	-1.40	-4.31	-4.95	-6.82	-8.15	2.49	5.33
	(4.09)	(1.36)	(1.32)	(1.27)	(2.02)	(2.07)	(1.34)	(2.14)
Fat	54.14	-4.38	-4.21	-7.07	-7.77	-7.58	-.357	-6.34
	(5.28)	(1.74)	(1.70)	(1.64)	(2.60)	(2.68)	(1.73)	(2.77)
Carbohydrate	152.89	-4.08	1.53	0.07	-24.26	-18.99	-7.50	0.30
	(12.11)	(4.02)	(3.92)	3.77)	(5.97)	(6.14)	(3.98)	(6.35)
Calcium	516.51	-86.38	-84.76	-155.93	-28.69	-19.18	-91.99	-61.79
	(58.62)	(19.45)	(18.98)	(18.26)	(28.91)	(29.73)	(19.23)	(29.29)
Iron	10.35	-0.51	-0.40	-0.40	-1.11	-1.32	0.10	1.64
	(0.79)	(0.26)	(0.26)	(0.24)	(0.39)	(0.40)	(0.26)	(0.41)
Vitamin A	5013.71	-884.44	-697.91	-894.57	-486.18	-1047.44	1814.65	14.17
	(882.69)	(292.53)	(285.47)	(274.79)	(434.90)	(447.19)	289.42)	(462.54)
Vitamin C	44.73	5.52	-5.04	-8.19	-12.30	-17.32	13.35	4.94
	(9.52)	(3.15)	(3.08)	(2.96)	(4.67)	(4.82)	(3.12)	(4.98)
Thiamine	0.85	-0.004	-0.01	-0.07	-0.07	-0.09	0.02	0.14
	(0.08)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.03)	(0.04)
Diet Composition: Percentage of Calories From:								
Protein	0.17	0.002	-0.005	-0.994	-0.0016	-0.004	0.008	0.017
	(0.01)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)	(0.000)	(0.003)
Fat	0.39	-0.011	-0.008	-0.015	0.001	-0.003	0.001	-0.018
	(0.01)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.004)	(0.006)
Carbohydrate	0.45	0.001	0.013	0.019	-0.007	0.002	-0.012	0.001
	(0.01)	(0.004)	(0.004)	(0.004)	(0.007)	(0.007)	(0.004)	(0.007)

Base classes for these sets of vairables are western region, rural farm, and white, respectively.

Characteristics of the Individual: Age, Sex, and Weight

Regression coefficients for age, sex, and weight are presented in Table 7. Age is included to be a representation of the changing physiological needs age is included to be a representation of the changing physiological needs throughout the lifecycle. The coefficients for calories, protein, fat, and carbohydrate indicate an increase in consumption up to the teenage classification (12-21 years) and a decrease thereafter. This pattern also holds for calcium, thiamin, and iron. The coefficients for the 60+ age group in the equations for vitamin A and C, indicate that older adults consume the highest level of these nutrients of all age groups. In the diet composition equations, significant differences exist in the percentage of calories from carbohydrate between the base class (22-40 years) and all other age classes. The 0-6 year old group have a significantly larger percentage of total calories from carbohydrate and a lower percentage from fat than do adults 22-40 and 40-60 years of age. These two adult classifications have the highest percentage of calories from fat of all the age groups specified in the model.

The coefficient for weight is significant in all equations except that for vitamin A, and, as hypothesized, the relationships are all positive. The diet composition equations indicate an inverse relationship between weight and the percentage of calories from carbohydrate. The results of the model indicate that as weight increases, individuals consume a higher percentage of calories from fat and protein and a lower percentage from carbohydrate.

Female was used as the base class in determining the differences in consumption between the sexes. As hypothesized, males consumed more of all nutrients than females. Females, however, consume a greater percentage of their calories from protein than do males.

Table 7

Regression Results for Nutrient Consumption Models

Regression Coefficients
(Standard Errors)

Nutrients	Sex	Weight	Age (Years) 0-6	7-12	13-21	40-60	60+
Calories	476.43	3.13	-380.77	128.89	171.81	-152.92	-243.41
	(21.21)	(.37)	(62.26)	(59.38)	(43.52)	(36.77)	(42.95)
Protein	18.56	0.16	-14.74	2.73	8.38	-4.71	-11.21
	(0.89)	(0.02)	(2.62)	(2.50)	(1.83)	(2.55)	(1.77)
Fat	22.03	0.18	-17.83	3.66	5.70	-6.40	-12.45
	(1.53)	(0.02)	(3.39)	(3.23)	(2.37)	(1.99)	(2.28)
Carbohydrate	48.42	0.16	-42.20	23.85	25.57	-21.07	-17.48
	(2.65)	(0.05)	(7.77)	(7.42)	(5.43)	(4.59)	(5.24)
Calcium	183.72	0.72	106.49	242.33	279.97	-76.87	-2.45
	(12.82)	(0.23)	(37.62)	(35.89)	(26.30)	(22.26)	(23.35)
Iron	3.26	0.013	-1.79	-0.56	0.79	-0.32	-0.88
	(0.17)	(0.00)	(0.49)	(0.48)	(0.36)	(0.50)	(0.34)
Vitamin A	885.56	0.14	-1633.64	-60.62	192.56	222.53	2214.89
	(192.80)	(3.39)	(536.03)	(536.90)	(395.69)	(334.34)	(381.47)
Vitamin C	6.57	0.081	-1.11	16.04	12.02	2.32	19.69
	(2.07)	(0.04)	(6.10)	(5.82)	(4.26)	(3.60)	(4.11)
Thiamine	0.33	0.002	-0.22	0.12	0.236	-0.08	-0.08
	(0.02)	(0.0003)	(0.05)	(0.05)	(0.04)	(0.03)	(0.04)
Diet Composition: Percent of Calories From:							
Protein	-0.004	0.0001	-0.001	-0.004	0.002	0.004	-0.003
	(0.002)	(0.0000)	(0.003)	(0.003)	(0.002)	(0.002)	(0.003)
Fat	0.0002	0.0002	-0.016	-0.008	-0.012	0.004	-0.009
	(0.002)	(0.0000)	(0.009)	(0.0080	(0.005)	(0.004)	(0.005)
Carbohydrate	-0.001	-0.0003	0.019	0.022	0.019	-0.011	0.018
	(0.003)	(0.0000)	(0.007)	(0.007)	(0.006)	(0.005)	(0.006)

Female is designated as the base class for the Sex variable.
For the age variable 22-39 is the base class.
Intercept values are presented in Table 5.2.

Education and Employment of the Female Head, Family Size

Regression coefficients and standard errors for these variables are presented in Table 8. The coefficient for education of the female head of household is positive and significant in the equations for carbohydrate, calcium, vitamin A, thiamin, and vitamin C. In terms of diet composition, as education of the female head of household increases, individuals consume a smaller percentage of calories from protein and a higher percentage from carbohydrate. Education is highly significant in the equation for vitamin C.

According to the results of the regression analysis, the number of hours worked by the female head of household is not an important factor in determining nutrient consumption. The work variable is negative and significant only in the equations for calories, carbohydrate, and vitamin C.

The work variable is significant, however, in all three of the diet composition equations. The results indicate that individuals who live in households where the female head is employed outside the home have a greater percentage of calories from fat and and a lower percentage of calories from protein and carbohydrate than those individuals who live in households where that is not the case. As discussed earlier in this paper, the sample statistics indicate that the percentage of calories consumed away from home is higher for individuals who live in households where the female head is employed outside the home (Table 4). Processed foods and foods consumed away from home may contribute to the higher fat consumption for these individuals, as these foods often contain more fat than other nutrients.

Family size is positive and significant in the equations for all nutrients except vitamins A and C. This implies that as family size increases, individual family members consume more protein, fat, carbohydrate, calcium, iron, and thiamin, and less of vitamins A and C. The results indicate that in terms of diet composition, as family size increases, the individuals consume a larger percentage of calories from carbohydrate and a smaller proportion from protein. This may be because larger families serve more meals that contain relatively less protein and more carbohydrate, whereas single households may eat more meat alone as a main dish.

Table 8

Regression Results for Nutrient Consumption Models

Regression Coefficients (Standard Errors)

	Characteristics of the Female Head			
Nutrients	Education	Employment	Family Size	Income
Calories	3.89	-0.95	25.55	65.34
	(3.16)	(-0.55)	(6.53)	(16.42)
Protein	-0.11	-0.003	0.49	3.32
	(0.13)	(0.03)	(0.27)	(0.70)
Fat	0.16	0.02	2.097	3.88
	(0.17)	(0.03)	(0.27)	(0.70)
Carbohydrate	0.97	-0.21	3.43	2.34
	(0.39)	(0.07)	(0.82)	(2.05)
Calcium	6.36	0.42	8.06	8.13
	(1.90)	(0.34)	(3.95)	(9.91)
Iron	0.02	-0.01	0.11	0.47
	(0.02)	(0.006)	(0.05)	(0.13)
Vitamin A	98.61	-6.51	-49.67	97.22
	(28.67)	(5.08)	(59.13)	(149.57)
Vitamin C	2.11	-0.09	0.39	10.49
	(0.31)	(0.05)	(0.64)	(1.61)
Thiamine	0.01	-0.0008	0.02	0.02
	(0.003)	(0.0005)	(0.005)	(0.01)
Diet Composition: Percentage of Calories From:				
Protein	-0.001	-0.0001	-0.001	0.0014
	(0.0001)	(0.00003)	(0.0003)	(0.0009)
Fat	0.0001	0.0002	-0.0001	0.004
	(0.004)	(0.00007)	(-0.0007)	(0.002)
Carbohydrate	0.001	-0.0001	0.001	-0.008
	(0.0004)	(0.00006)	(0.0009)	(0.002)

Income

The regression coefficients and standard errors for income are included in Table 8. The coefficient for per capita income is positive in the equations for all nutrients. The relationship is not significant, however, for carbohydrate, calcium, vitamin A and thiamin. For the remainder of the nutrients, the relationship is significant at the 5% level. As with education, the relationship between income and vitamin C consumption is highly significant.

Income is sigificant in the three diet composition equations. The coefficient is negative for carbohydrate and positive for fat and protein. Because these equations estimate the percentage of calories from each nutrient source, the signs of the coefficients imply that as income increases, individuals decrease the percentage of calories from carbohydrate and substitute fat and protein in the diet.

Income is also positive and significant in the equation for calories. Therefore individuals at higher income levels consume more calories as well as a different distribution of calories when compared with individuals at lower income levels. It is expected, though, that a portion of the increase in calories as income rises is due to increased consumption of alcohol, as well as fat and protein.

Income Elasticities

Income elasticities for the significant income consumption relationships are presented in Table 9. These elasticities were calculated at the selected income levels, holding all other variables constant at the mean. The estimated elasticities are generally low, indicating that nutrient consumption is rather unresponsive to changes in income. Vitamin C has the highest income elasticity, as well as the greatest range in elasticity across income levels.

Income and the Quality of the Diet

Based on the regression results, nutrient consumption and diet composition values were predicted for selected income levels over the range of the sample. In these predictions all other variables were held constant at their means. In order to determine the quality of the diet at various income levels in the sample, these predicted values are compared to the recommended daily allowances for nutrients and the U.S. dietary guidelines for the diet composition values. The effect of income on the consumption of calcium, thiamin, and vitamin A will not be presented because income was

TABLE 9

Income Elasticities for Estimated Nutrients at Selected Income Levels

Per Capita Income	Calories	Fat	Protein	Vit C	Iron
150	.040	.055	.050	.199	.040
250	.039	.054	.049	.181	.039
500	.038	.052	.048	.160	.038
2,000	.038	.048	.045	.131	.036
3,800	.036	.047	.048	.120	.035
8,000	.035	.045	.042	.111	.034
12,000	.034	.044	.041	.106	.034
25,000	.033	.043	.040	.100	.033
40,000	.033	.042	.040	.094	.033
BETA	65.34	3.38	3.32	10.49	.47
s.e.	(16.42)	(.70)	(.70)	(1.61)	(.47)

Note: Income levels were selected to be representative of the range of income in the sample (minimum $140; maximum $49,000; mean $3,800).

not found to be a significant factor affecting the consumption of these nutrients.

Protein consumption exceeds the recommended dietary allowance for the entire range of income in the sample. Consumption of vitamin C also exceeds the recommended level for all incomes except at the extreme low end of the scale. Including the effect of region in the prediction indicates that this deficiency is greater for low income individuals living in the southern region of the United States. The model indicates, however, that even for individuals in the lowest income level, vitamin C consumption is not more than 10% below the recommended daily allowance of 60 milligrams per day.

Though it increases with increases in income, iron consumption is inadequate for women at all income levels. Even at the highest income recorded in the sample, the model indicates that average iron consumption for women is 20% below the recommended amount of 18 milligrams per day. This deficiency is greater for individuals in certain urbanizations and regions where iron consumption is lower than the average. Among males, iron consumption is adequate at all income levels.

Table 10 presents the predicted values for the diet composition equations at selected levels over the range of income. As income increases from its minimum level to the maximum in the sample, holding age constant, the distribution of calories changes from 40% fat, 43% carbohydrate, and 17% protein to 42% fat, 40% carbohydrate, and 18% protein. It is clear that though there is a slight change in the distribution of calories, diet composition remains relatively constant as income increases. These predicted values for diet composition also indicate that the percentage of calories from fat is high at all income levels. Even at the lowest income value specified, percentage of calories from fat is 40%, 10% above that recommended by the dietary guidelines.

Calories Away from Home

Calories Away from Home

As discussed, the effect of food away from home on nutrient consumption was specified in the model by the percentage of calories consumed away from home. The values then entered the model in six separate variables, one for each of the six specified age groups.

As previously noted, the percent of calories consumed away from home varies across several characteristics of the sample other than age. As shown in Table 4, the percentage of calories consumed away from home increases with income and the number of hours worked by the female head of the household. The values in the table also show that white individuals consume a higher percentage of calories away from home than either black or 'other' races.

The regression coefficients and standard errors for the calories away from home/age variables in the nutrient consumption and diet composition equations are presented in Table 11. The results show that no consistent relationship across age groups exists between calories away from home and nutrient consumption. Age groups 13-21 and 22-44 have the largest number of significant relationships between calories away from home and nutrient consumption. Sample statistics show that individuals in these age groups are the largest consumers of food away from home (Table 3.7).

Generally, there is no significant relationship between the consumption of protein, fat, and carbohydrate, and the percentage of calories eaten away from home. Similarly, the calories away from home variables are insignificant in the diet composition equations.

TABLE 10

Predicted Diet Composition Values Over the Range of Income

Per Capita Income ($000)	Percentage of Total Calories: Protein	Fat	Carbo-hydrate
0.25	16.3	39.8	43.3
0.5	16.3	40.0	43.1
1	16.3	40.3	42.6
3	16.4	40.7	41.7
5	16.5	40.9	41.3
12	16.6	41.3	40.6
25	16.7	41.6	40.0
35	16.7	41.7	39.7
50	16.7	41.9	39.4

Values were calculated for the 22-40 year age group. All other variables except income are held constant at the mean level.

Table 11

Regression Results for Nutrient Consumption Models

Regression Coefficients
(Standard Errors)

Nutrients	Percentage of Calories Away from Home by Age Group (Years) 0-6	7-12	13-21	22-40	40-60	60 +
Calories	465.44	89.71	83.59	-34.89	-56.46	-44.27
	(165.64)	(157.39)	(109.95)	(91.82)	(110.71)	(177.08)
Protein	16.49	1.92	-8.17	-5.32	-2.76	-1.39
	(6.99)	(6.64)	(4.46)	(3.88)	(4.68)	(7.32)
Fat	13.90	-0.98	5.89	-1.48	-1.27	-4.49
	(9.97)	(8.17)	(6.01)	(5.10)	(6.05)	(9.76)
Carbohydrate	73.23	24.51	15.95	-14.45	-10.28	-3.11
	(20.69)	(19.77)	(13.75)	(4.93)	(13.89)	(22.21)
Calcium	-22.17	33.58	-138.04	-109.17	-79.30	-303.76
	(100.77)	(95.94)	(66.37)	(55.42)	(67.20)	(106.96)
Iron	-3.52	0.55	-1.58	-1.92	-0.84	-1.86
	(1.35)	(1.28)	(0.92)	(0.75)	(0.90)	(1.45)
Vitamin A	193.25	526.29	-1197.48	-2255.68	546.09	-4353.44
	(1486.53)	(1434.03)	(1006.28)	(832.35)	(1013.13)	(1612.38)
Vitamin C	4.61	23.06	-30.71	-27.73	-16.75	-27.55
	(16.46)	(15.48)	(10.81)	(8.97)	(10.87)	(17.44)
Thiamine	0.29	-0.04	-0.38	-0.26	-0.23	-0.10
	(0.15)	(0.13)	(0.10)	(0.08)	(0.10)	(0.15)
Diet Composition: Percentage of Calories from:						
Protein	0.0008	-0.009	-0.023	-0.008	-0.003	0.0004
	(0.009)	(0.009)	(0.006)	(0.005)	(0.006)	(0.009)
Fat	-0.014	-0.035	0.014	0.002	-0.008	-0.005
	(0.019)	(0.018)	(0.013)	(0.01)	(0.012)	(0.020)
Carbohydrate	0.031	0.049	0.009	0.018	0.005	0.002
	(0.023)	(0.022)	(0.016)	(0.02)	(0.015)	(0.025)

The lack of relationship between calories away from home and fat consumption for the 13-21 and 22-40 year old age groups does not confirm the hypotheses set forth previously. Because the 13-21 and 22-40 year old individuals are the largest consumers of fast food, it was hypothesized that for these age groups, calories away from home would be significantly related to fat consumption and the percentage of calories from fat. Several factors may be responsible for the insignificant relationships.

The nutrient consumption equations were estimated for the entire sample, including individuals who did not consume any food away from home on the day surveyed. Among the individuals who did consume foods away from home there is a wide variation in the types of foods consumed. A separate regression was run for those individuals who reported consumption of food away from home on the day surveyed. The signs and significance of the variables do not differ significantly from those estimated for the entire sample including for the 13-21 and 22-40 year age groups. The results from this regression using a subset of the sample support the conclusion that calories away from home is not significantly related to the consumption of fat, protein, and carbohydrate, or the percentage of calories from these nutrients.

It also is worth noting again that there is a suspected amount of under-reporting of foods consumed away from home. Soft drinks, candy bars, potato chips and other foods typically eaten as snacks may be easily forgotten and not reported in the day's intake record. This under reporting is also hypothesized to have had an impact on the coefficients expressing the relationship between foods away from home and the consumption of fat, protein, and carbohydrate.

The percentage of calories consumed away from home significantly affects the consumption of all the other nutrients estimated, namely calcium, iron, vitamin A, thiamin, and vitamin C. The regression coefficients in Table 11 show that calories away from home have a negative impact on the consumption of these nutrients for several age groups but most consistently for the 13-21 and 22-40 years old individuals.

Nutrient Deficiency

Figures 1-5 express graphically the relationship between the percentage of calories away from home and the consumption of specific nutrients, for the age groups for which there was a significant relationship between nutrient consumption and food away from home. As with the analysis of income and diet quality, the predicted values for nutrient consumption over the range of calories away from home will be compared to the recommended daily allowances. The relationships in the graphs were plotted by holding all other variables constant at the mean level.

Figure 1 shows that thiamin consumption is estimated to be adequate at all levels of food away from home. Similarly vitamin C comsumption is adequate for all age groups except the 13-21 year olds (Figure 2). For this age group the consumption of vitamin C falls below the recommended level of 60 milligrams when calories away from home exceed 45% of total calories. This implies that if an individual in this age group consumes more than two meals per day away from home, he or she may be deficient in vitamin C. Similarly, Figure 3 illustrates that the vitamin A consumption by 22-40 year old individuals may be inadequate if the percentage of calories away from home exceeds 27%.

As discussed in the section on income, calcium and iron consumption are estimated to be below the recommended level when the percentage of calories away from home is held constant at the mean level. As depicted by Figure 5, iron consumption for females is well below the RDA, even for individuals who do not consume any calories away from home. This indicates that while an increase in the percentage of calories away from home does have a negative impact on iron consumption, food away from home does not appear to be a significant factor contributing to iron deficiency.

Individuals who consume a high percentage of calories away from home are at increasing risk of calcium deficiency (Figure 4). Consumption of calcium declines as the percentage of calories away from home increases. As with iron, however, the consumption of calories away from home is not the major factor causing calcium deficiency.

Table 12 summarizes the significant relationships between calories away from home and nutrient consumption. The size and significance of the coefficients for the 13-21 year age group indicate that the diets of these individuals are most affected by the consumption of foods away from home. This potential for deficiency is increased for various subgroups of the population for whom other characteristics are negatively related to nutrient consumption.

Nutrient Density

Another major issue is the effect food away from home has on the quality of the diet as measured by nutrient density. Those who consume a significant proportion of their food away from home may consume adequate amounts of nutrients, but do so at the cost of a greater caloric intake. It is hypothesized that the nutrient per calorie ratio is lower in the types of foods consumed away from home, especially the foods served at fast food restaurants.

Table 13 presents a breakdown of nutrient density for various levels of calories away from home. The nutrient density values were calculated by dividing the milligrams of each nutrient consumed by total calories in the diet. Values were calculated for iron, thiamin, calcium, vitamin A and vitamin C. The density values were calculated for the 13-21 and 22-40 year age groups as well as for the entire sample. These groups consume the highest percentage of calories away from home and therefore may have diets with nutrient densities that are lower than the average.

The figures support the hypothesis that nutrient density declines as percentage of calories consumed away from home increases. The decline,

Figure 1: Thiamin Consumption By Percent of Calories Away from Home
(3 Age Groups)

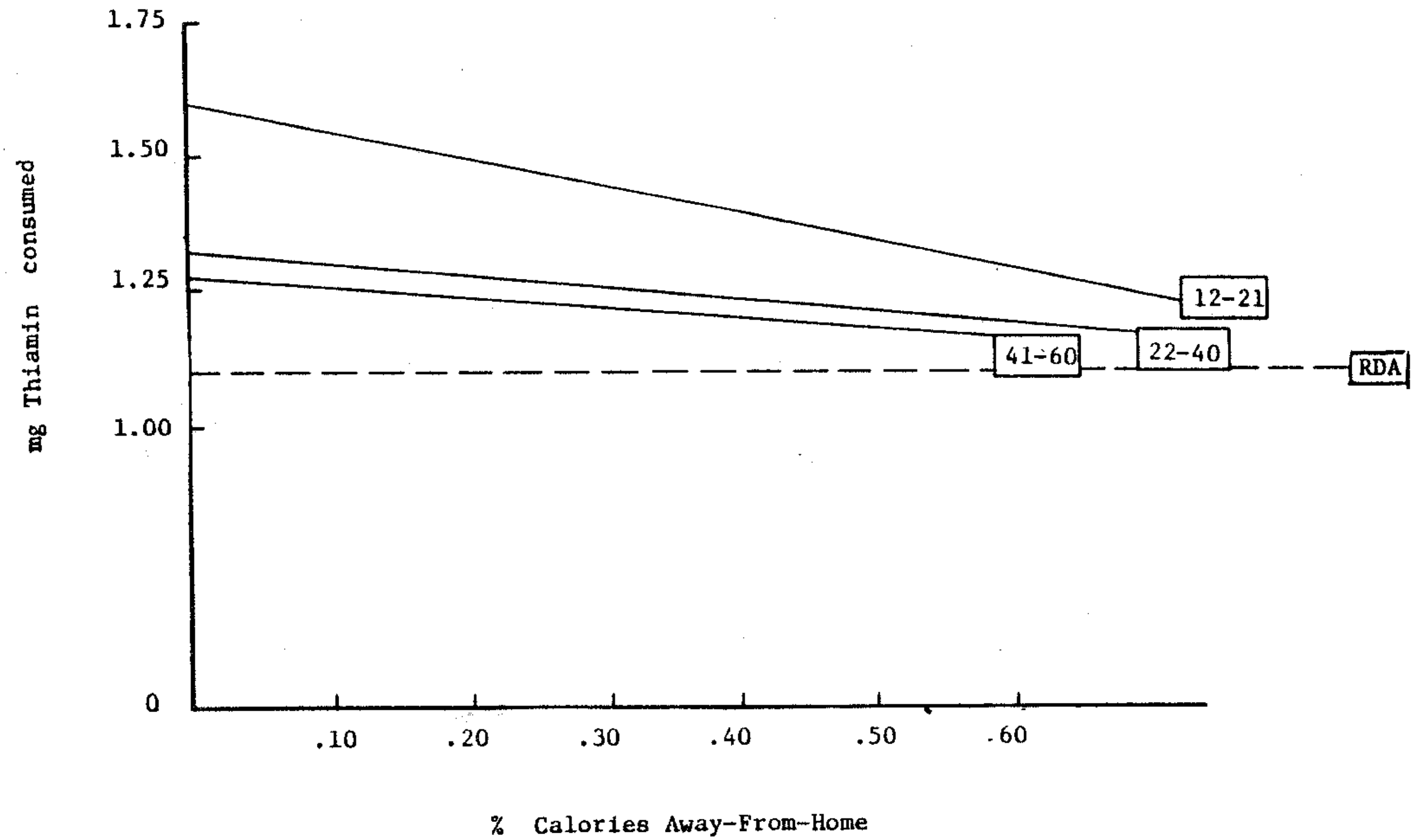

Figure 2. Vitamin C Consumption by Percent of Calories Away from Home (4 Age Groups)

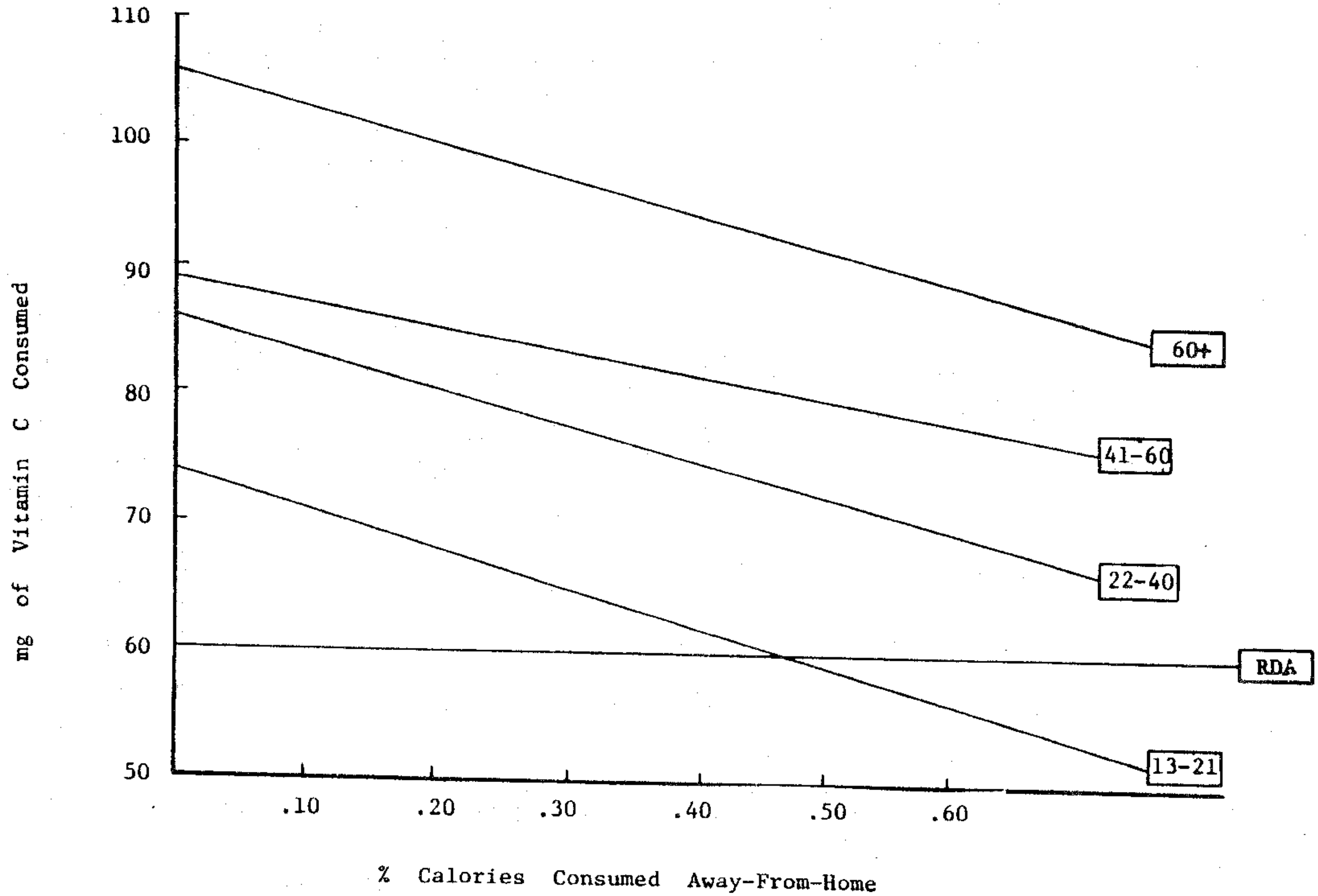

Figure 3: Vitamin A Consumption by Percent of Calories Away from Home
(2 Age Groups)

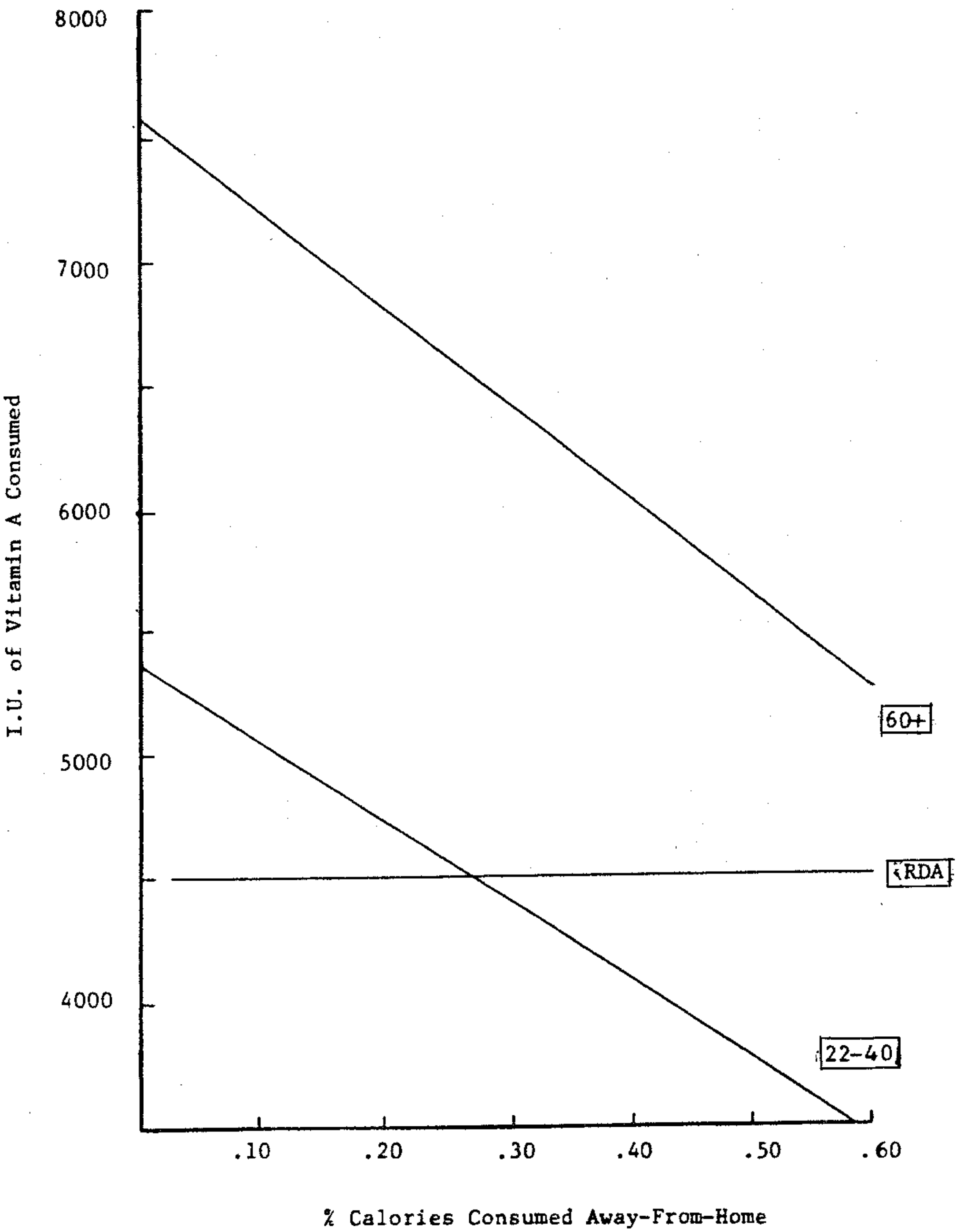

Figure 4: Calcium Consumption by Percent of Calories Away from Home
(3 Age Groups)

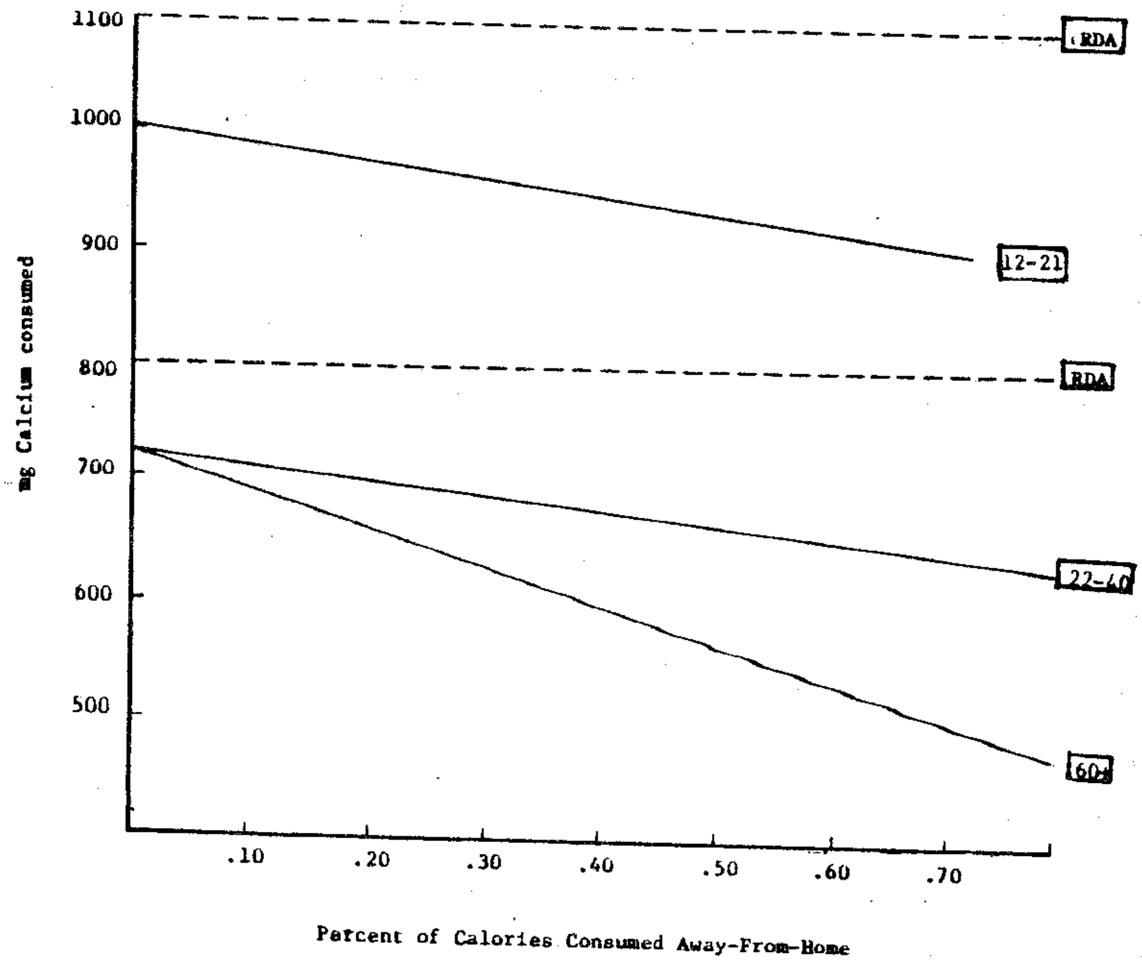

Figure 5: Iron Consumption by Percent of Calories Away from Home
(2 Age Groups)

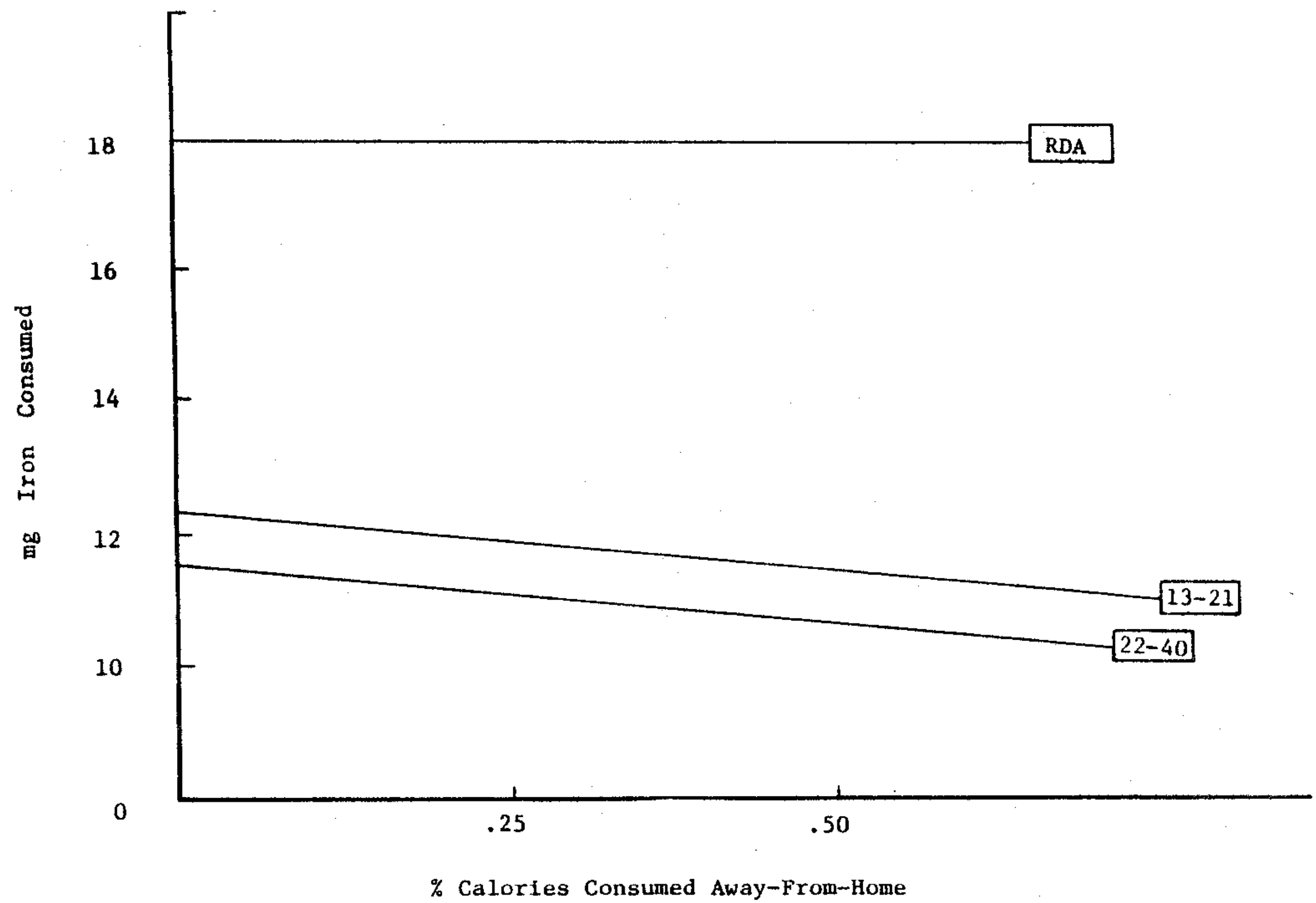

TABLE 12

Summary of Significant Calories Away from Home/Age Variables

Regression Coefficient
(Standard Error)

Nutrients	Calories Away From Home / Age					
	0-6	7-12	13-21	22-40	41-60	60+
Calcium			-138.04 (66.53)	-109.17 (55.32)		-303.76 (107.06)
Iron	-3.52 (1.35)		-1.58 (0.90)	-1.92 (0.74)		
Vitamin A				-2255.7 (832)		-4353 (1612)
Thiamine			-0.38 (0.15)	-0.26 (0.10)	-0.23 (0.10)	
Vitamin C			-30.71 (10.79)	-27.72 (8.97)	-16.75 (10.87)	-27.55 (17.38)

TABLE 13

Nutrient Density Values by Percentage of Calories Away from Home

(Milligrams per Calorie)

KALRT: All Ages	Calcium	Iron	Vit C	Vit A	Thiamine	Number of Observations
0	.427	.0080	.054	3.499	.0007	1891
.01-.10	.417	.0069	.051	2.947	.0007	408
.11-.20	.401	.0069	.049	2.948	.0007	506
.21-.30	.410	.0068	.047	2.905	.0007	369
.31-.40	.421	.0067	.045	2.523	.0007	287
.41-.50	.421	.0068	.046	2.582	.0007	191
.51 +	.371	.0071	.042	2.635	.0006	267
Ages 13-21						
0	.429	.0071	.035	3.154	.0007	42
.01-.10	.466	.0065	.047	2.699	.0007	64
.11-.20	.451	.0066	.041	2.587	.0007	88
.21-.30	.460	.0067	.046	2.625	.0007	80
.31-.40	.486	.0066	.040	2.627	.0007	66
.41-.50	.441	.0062	.041	2.829	.0006	52
.50 +	.419	.0082	.031	1.953	.0006	52
Ages 22-40						
0	.365	.0067	.0412	2.282	.0007	70
.01-.10	.349	.0069	.0464	2.788	.0007	111
.11-.20	.363	.0070	.0431	2.233	.0007	133
.21-.30	.355	.0069	.0433	3.198	.0007	93
.31-.40	.347	.0064	.0402	1.882	.0006	79
.41-.50	.373	.0067	.0500	2.654	.0007	50
.50 +	.322	.0066	.0361	2.232	.0006	95

however, is not dramatic. In fact for iron and vitamin A, nutrient density first decreases and then increases. For calcium, the nutrient density decreases then increases, then decreases again. The level of calories away from home in which these changes occur is not constant across age groups or nutrients.

The main conclusion that can be drawn from this breakdown of nutrient density values is that the nutrient density of the diet is lowest for individuals who consume 30% to 40% of total calories away from home. This conclusion does not hold for all nutrients across all age groups but is generally true for the sample as a whole. Nutrients that are exceptions to this are calcium (for the 13-32 age group) and iron (for all ages).

Clearly, the impact of food away from home on the nutrient density of the diet depends on the types of foods that are eaten away from home as well as the percentage of total calories.

Summary of Results

Socioeconomic Characteristics and Nutrient Consumption

The results of the nutrient consumption models indicate that while overconsumption of fat is evident for all segments of the population, no particular socioeconomic characteristic can be determined to be the main factor contributing to this overconsumption. Based on the estimation of the diet composition equations, the distribution of calorie intake estimated at the mean level for all explanatory variables is 17% from protein, 43% from carbohydrate and 42% from fat. The percentage of calories from fat is considerably higher than the 30% recommended in the dietary guidelines. Characteristics determined to have a positive relationship with fat consumption include income, hours worked by the female head of the household, and weight of the individual. These variables are also related to the percentage of calories from fat. Variation in fat consumption associated with these factors, however, is very small. One important implication of these results is that with future increases in income and the number of women working outside the home, the population as a whole will consume more fat and a higher percentage of calories from fat.

In terms of the consumption of other nutrients, the conclusion from this analysis is that the diets of the majority of individuals in the United States meet or exceed the recommended daily allowances for protein, thiamin, and vitamins C and A. Consumption of most nutrients is lowest in the southern region of the United States, particularly for rural non-farm residents and those living in urban areas.

Deficiencies do exist in the consumption of some nutrients. Iron consumption is 30-40% below the recommended level for the majority of pre-menopausal women. Iron consumption increases with income, but for most women is below the RDA even at higher income levels. Employment of the female head of household has a negative impact on individual iron consumption. Therefore increased employment of female household heads may imply further iron deficiency among women. Surprisingly, the education level of the female head is not a significant factor determining iron consumption by individuals. This indicates that individuals with higher education are not necessarily aware of the problem of iron deficiency.

Calcium consumption is also below the RDA for most young adults 13-21 years of age, especially among blacks and individuals living in the southern region of the United States. Income is not related to calcium consumption, nor is employment of the female head of household. Education of the female head is positively related to calcium consumption, but even in households in which the female head is well educated individuals do not necessarily consume adequate amounts of calcium.

Foods Consumed Away from Home

Consumption of calories away from home was included in the model to determine how food away from home affects the quality of the diet. The main conclusion from the analysis is that consumption of foods away from home does not contribute to overconsumption of fat. This result is surprising in light of the discussion of the nutrient content of foods typically consumed away from home (Chapter 1). These results suggest that while Americans are eating an increasing percentage of foods away from home, on the whole the types of foods consumed are not significantly contributing to the level of fat in the diet.

The results did indicate, however, that for some individuals, vitamin and mineral consumption is adversely affected by the consumption of foods away from home. Specifically, consumption of food away from home has a negative impact on the consumption of thiamin, and vitamins A and C for the 13-21 and 22-40 year old age groups. For the population as a whole, these two groups consume the highest percentage of total calories away from home. For these age groups, thiamin consumption is adequate at all levels of food away from home. Consumption of vitamins C and A, however, may be below the recommended level for teenagers and young adults who consume more than two meals a day away from home. Consumption of food away from home is also negatively related to the consumption of iron and calcium for this age group, and contributes to the problem of deficient consumption of these nutrients.

The analysis of nutrient density for the sample found that nutrients per calorie were significantly lower for individuals who consume more than 30% of total calories away from home. This analysis included individuals in all age groups. The diets of these individuals may be nutritionally adequate, but a higher calorie consumption is required to achieve this level of nutrient intake.

Among the characteristics analyzed, consumption of food away from home and hours worked by the female head of household were most often negatively related to consumption of nutrients beneficial to health. These two factors are clearly related in that as hours worked by the female head increase, family members consume more food away from home (see Table 3.3). Hours worked by the female head are related to increased fat consumption, and both this factor and the consumption of food away from home are linked to deficient consumption of calcium, iron, and vitamin C for certain segments of the population.

Limitations of the Study

The results of this study should be considered in lightof two main limitations. The first limitations arises as a result of deficiencies in the data. As discussed in previously, there is a serious under-reporting of calories in the individual intake resords. On the average, individuals reported consuming fewer than the recommended amount of calories for their age and sex. It is suspected that foods typically under-reported are snack foods, beverages, and foods consumed away from home. This bias in the data may be partly responsible for the lack of significance of the variables in the estimation of fat consumption, particularly food away from home. The under-reporting of food away from home may also be affecting the estimation of the relationship between this varialbe and nutrient consumption. If the data set had been more complete, the results might indicate a more significant impact of food away from home on the quality of the diet.

Another consideration in interpretating the results is the extermely low R^2 for the regression equations . This indicates that the independent variables in the model (the socioeconomic characteristics and calories away from home) explain only a small percentge of the total variance in food consumption among the individuals in the sample. In this study only those variables with a statistically significant t statistic were considered to have an impact on the consumption of the nutrient. Clearly, the low R^2 values indicate that these variables are only part of a large number of factors that affect nutrient consumption.

Policy Implications

The results from the analysis confirm that nutritional problems do exist for different segments of the population. Previous attempts by the government to intervene to improve the quality of the American diet have met with limited success. Individuals choose to eat certain foods for many reasons, nutrition and health being only one concern. The results from this analysis have shown that education by the female head of household is not related to fat consumption. This suggests that increasing education over all may not lead to a reduction in fat consumption.

The government can, however, formulate specific policies to help individuals make positive changes in their food habits. This intervention may take two specific forms : 1) improve the availability of nutrition information to assist the public in making recommended changes in the diet, and 2) make adjustments in government policy to reduce the level of fat and other problem nutrients in the U.S. food supply.

The primary role that the government should take in instituting this change is to provide more information on the health risks of overconsumption. The dietary guidelines are a positive step in this direction. However, the public needs to better understand the health risks they are facing before they will be motivated to make positive change in their diets. Along with the problem of excess fat consumption, efforts must be made to increase public awareness of the sub-optimal consumption of iron by women and calcium by teenagers. This information should be widely presented and in a form that is easily understood. More use should be made of TV and other forms of mass media, as well as increased emphasis on nutrition education in schools.

There are many indications that the American public is concerned about nutritional problems and interested in learning more about the relationship between nutrition and health. Consumers, however, are constantly being bombarded with conflicting information on what they should and should not eat. Advertising by the food industry is one of the major sources of misleading and often incomplete information. The deficiency in calcium consumption for teenagers is an example of how advertising and lack of nutritional awareness among the public leads to consumption of foods that are nutritionally inferior to the foods they replace in the diet. Analysis of beverage consumption by teenagers reveals that for many individuals milk consumption is being replaced by consumption of soft drinks. Government intervention into this market may be required to regulate the forces that may be leading to reduced consumption of calcium.

Government intervention to improve nutrition information also could take the form of cooperation with food manufacturers by encouraging them to promote foods that are healthful. Vitamin C, for example, is widely advertised as an important nutrient and some manufacturers proudly disclose the vitamin C content of their products. This has served the purpose of making consumers aware of the need for vitamin C and some of the foods that are sources of the vitamin. The government could encourage similar advertising for calcium and iron to make the public more aware of the needs for these nutrients in the diet.

An essential accompaniment to changes in nutrition information is intervention to improve the nutrient content of the U.S. food supply. This does not have to be accomplished through direct intervention or regulation. The current grading and labeling requirements for some products may actually encourage the production of foods with excessive components of fat and other problem nutrients. For example, grading standards for beef are based on the degree of marbeling (fat within the muscle tissue) of the meat. Similarly, dairy policy provides a price differential which favors producing milk with a higher butterfat content. A change in these grading and pricing practices may provide the necessary incentives to producers of agricultural products to modify the fat content of their products. Such legislation is often politically difficult to implement and it may be some time before these standards can be changed. Public awareness and concern may help oppose the resistance of special interest groups and make such legislation possible.

Recent changes in the food industry indicate that strict government regulation may not be necessary to improve the nutritional quality of processed foods. In the past few years, as public awareness of nutritional issues has increased, the food industry has introduced new foods that contain lower amounts of some problem nutrients such as fat, sugar, and sodium. Low sugar jams, low fat mayonnaise and many low sodium products are now readily available. These foods are not produced with the intention to sell to the "special diet" group, but are there for members of the general public who are interested in reducing the consumption of these nutrients. Government labeling standards often require manufacturers to label these products "imitation" as in the case of mayonnaise, or "spread" instead of jam. These labeling standards are often based on government recipies or "standards of identity" that require a certain fat or sugar content of a product for it to assume a product name. The government should encourage the production and consumption of these types of products by changing these labeling standards to be more in keeping with the nutritional needs of the population.

These changes in food manufacturing represent an encouraging trend. Increased public awareness and concern for the nutritional quality of the food supply may increase the demand for nutritionally superior foods. Manufacturers may then be induced to respond with production of better products. Government activity to improve nutritional information and the quality of the food supply should augment this public awareness and stimulate positive change in the quality of diets in the United States.

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