Unlocking the Mystery Between Nutrition Knowledge and Diet Quality

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No two people eat exactly alike, but what accounts for the vast differences in diet quality? Diet quality depends on the foods eaten, how they are stored and prepared, and other factors, such as quantities and proportions that influence the nutrient content of meals. Some people's diets are rich in fruits and vegetables, while others are high in grains, meats, or dairy products, and still others consume primarily fried foods. Some dine out frequently, while others produce and prepare their own food. This article examines the role that nutrition knowledge plays in shaping people's diets.

In general, four categories of factors influence food consumption: consumers' incomes, food prices and the prices of other products and services, consumers' knowledge of health and nutrition, and consumers' tastes and preferences. To change consumption, one of these influences must change. For example, nutrition-education efforts attempt to change consumers' knowledge and behavior, while increasing consumer incomes affects tastes and preferences.

It is well-known that personal and household characteristics—such as education, race, ethnicity, and family size—are associated with certain patterns of food consumption. For example, some population groups are more lactose-intolerant than others, and thus consume fewer dairy products. Larger households, usually younger and containing children, consume more soft drinks per person than do older, smaller families. However, personal and household characteristics not only reflect the underlying tastes and preferences of people but also may have an informational or knowledge effect. The most common example cited is that more-educated individuals may acquire, process, and retain information more easily and thus have a higher stock of nutrition knowledge, which is then reflected in the choice of certain foods.

The problem for analysts has been the lack of a unified data set that simultaneously collects measures of nutrition knowledge, demographic information, and food consumption data. Without such information, researchers cannot separate the effect of nutrition knowledge (which is highly correlated with some socioeconomic characteristics) on consumption from the effect of taste and preferences (which cannot be measured directly but must be inferred from personal and household characteristics). Consequently, the influence of demographic factors on food consumption may reflect a combination of an informational effect and a taste effect. Some attributes (such as education) may have an informational effect, some others (such as age) may have a predominantly taste effect, and still others (such as race and ethnicity) may have both effects. Moreover, the two effects may reinforce each other, or work in opposing ways.

Starting in 1985, USDA initiated the Continuing Survey of Food Intakes by Individuals (CSFII). In 1989, the CSFII companion survey, the Diet and Health Knowledge Survey (DHKS) was added. This component provided measures of respondents' health and nutrition knowledge along with their sociodemographic characteristics. These were the first nationally representative surveys to measure both food intake and nutrition knowledge of the same individuals. Using data from the CSFII, USDA has constructed an instrument called the Healthy Eating Index (HEI) to mea-

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sure the overall quality of an individual's diet. Developed by USDA's Center for Nutrition Policy and Promotion, the HEI measures how well a diet conforms to the recommendations of the *Dietary Guidelines for Americans* and the Food Guide Pyramid (see box on measuring diet quality). Introduced in 1995, the HEI provides an important new tool for assessing the quality of Americans' diets and also provides a better understanding of the impact of food choices on their health. It made available for the first time a single summary measure to monitor changes in food consumption patterns. It serves as a report card on the American diet, allowing researchers to analyze how Americans eat, and aids USDA in more effectively promoting proper nutrition. Preliminary analysis indicated that the diets of most Americans need improvement, and some are more likely than others to consume a poor diet.

A major problem faced by nutrition educators and public-health professionals in their efforts to achieve further dietary improvements is a lack of specifics on consumers' use of diet-health information. For example, to what degree does nutrition information access and use vary across different segments of the population? Likewise, does more nutrition information help people to improve their diet quality? Any understanding of factors slowing the adoption of healthful diets requires empirical knowledge of how diet-health information and its effect on dietary choices vary across the population. Such knowledge can be useful for targeting nutrition-education programs, for promoting and marketing foods, and for forecasting food consumption trends.

Our objective was to separate the influence of taste and preferences from the effects of nutrition knowledge on a person's HEI through econometric models. We make a strong case that information and knowledge are keys that will help unlock the door to better diets and in turn better health, longer lives, and children with improved cognitive and learning abilities.

Measuring Diet Quality: The Healthy Eating Index

The HEI measures overall diet quality by evaluating how an individual's diet stacks up to the 10 dietary recommendations in the *Dietary Guidelines for Americans* and the Food Guide Pyramid.

The first five HEI components measure the extent to which a person's diet conforms to the Food Guide Pyramid serving recommendations for the grain, vegetable, fruit, milk, and meat groups. For each of these five food-group components of the HEI, an individual's diet is assigned a score between 0 and 10. Those consuming the recommended number of servings received a maximum score of 10 (a score of zero was assigned for any food group where no items from that food group were eaten). Intermediate scores were given for intakes between the two limits, calculated proportionately to the number of servings consumed. For example, if the recommended number of servings for the grain group was eight and an individual consumed four servings of grain products, then the person would receive a score of 5 points (half of 10) for the grain component of his or her HEI.

HEI components 6-10 measure the extent to which a person's diet conforms to the Dietary Guidelines recommendations for total fat, saturated fat, cholesterol, sodium, and variety. An individual's diet was assigned a score between 0 and 10 for these components as well. The scores for fat and saturated fat were related to their consumption in proportion to total food energy (calories). Fat intakes less than or equal to 30 percent of total calories were given a score of 10. The score declines to zero when the proportion of fat to total calories was 45 percent or more. Intakes between 30 and 45 percent were scored proportionately. Saturated fat intake of less than 10 percent of total calories received a score of 10, while zero points were given for saturated fat intake of 15 percent or more of calories. Scores were proportionately given for fat intake between 10 and 15 percent of total calories.

Scores for cholesterol and sodium were given based on milligrams consumed in the diet. A score of 10 was given for cholesterol intake less than or equal to 300 milligrams daily. Zero points were given for intake at or over 450 milligrams. For sodium, the maximum score meant intake was less than or equal to 2,400 milligrams. A zero score was given for sodium intake at 4,800 milligrams or higher.

Dietary variety was assessed by totaling the number of "different" foods eaten in amounts sufficient to contribute at least half of a serving in one or more of the five pyramid food groups. Food mixtures were broken into their component ingredients and assigned to relevant food groups. Similar foods, such as two different forms of potatoes or two different forms of white bread, were grouped together and counted only once in measuring the score for variety. A maximum score of 10 was awarded if 16 or more different food items were consumed over a 3-day period. A score of zero was given if six or fewer distinct food items were consumed.

Complete details on the construction of HEI can be found in the USDA's Center for Nutrition Policy and Promotion publication *The Healthy Eating Index*, CNPP-1, Oct. 1995.

Variations in Diet Quality: A First Look...

Consumers' sociodemographic background affects their food choices in two ways—nutrition information and taste / preferences. Sociodemographic background may influence consumers' nutrition knowledge, which, in turn, affects their food choices. Sociodemographic background also shapes tastes and preferences, which also influence food choices.

For instance, people with higher levels of education may acquire more information about the health effects of foods and this may induce them to improve the quality of their diets by, for example, consuming more fruits and vegetables. Similarly, women may be more aware of diet-health relationships than men, and this increased awareness may be translated to better quality diets. Conversely, food choices may be influenced by a person's ethnicity, which reflects tastes acquired through tradition. For example, Hispanics may choose a different type of diet than others due to traditional eating habits. Or, a person's food tastes may change with age due to physiological changes. These knowledge and taste effects may reinforce each other, or work in opposing ways.

A Closer Look: Nutrition Knowledge

The following descriptive analysis of average HEI and nutrition knowledge scores for different population groups should be interpreted cautiously, since some characteristics are correlated. For example, higher HEI scores that are associated with higher education levels may be partially caused by higher income, since education levels tend to influence income levels.

We used responses to two sets of questions in the DHKS to develop measures of nutrition knowledge. The first measure represents the respondents' knowledge of the nutrient content of foods. The second measure reflects awareness of the health effects of various dietary choices.

Nutrient Content

Respondents were asked to choose the correct answer from each of a series of questions about sources and occurrence of various food components and nutrients in common food items. Our measure of nutrient-content knowledge represents the number of correct answers given by a respondent to 21 of these questions. Respondents

Table 1
Most People Can Identify Which Foods Have More Fat, Fiber, and Cholesterol

Question	Respondents answered— Correctly	Incorrectly
	Percent	
Which has more fiber?		
Fruits or meats	77.7	22.3
Cornflakes or oatmeal	79.5	20.5
Whole-wheat bread or white bread	91.8	8.2
Orange juice or an apple	74.0	26.0
Kidney beans or lettuce	56.3	43.7
Popcorn or pretzels	73.6	26.4
Which has more cholesterol?		
Liver or T-bone steak	52.3	47.7
Butter or margarine	87.2	12.8
Egg whites or yolks	84.6	15.4
Skim milk or whole milk	95.0	5.0
Which has more fat?		
Regular hamburger or ground round	87.8	12.2
Loin pork chops or pork spare ribs	72.0	28.0
Hot dogs or ham	61.3	38.7
Peanuts or popcorn	90.5	9.5
Yogurt or sour cream	85.9	14.1
Porterhouse steak or round steak	58.8	41.2
Ice cream or sherbet	95.0	5.0
Roast chicken leg or fried chicken leg	94.6	5.4
Which kind of fat (saturated or polyunsaturated) is more likely to be a liquid rather than a solid? Or, are they equally likely to be liquids?	29.6	70.4
Is cholesterol found in vegetables and vegetable oils, animal products, or all foods containing fat or oil?	38.7	61.3
If a food is labeled cholesterol-free, is it also low in saturated fat, high in saturated fat, or either?	55.6	44.4

Note: Correct answers are underscored here. Source: 1989-90 Diet Health Knowledge Survey, USDA.

answered an average of 15 questions correctly (table 1).

These questions probed knowledge of the fiber, cholesterol, and fat content of foods. For example, respondents were asked to identify which of two foods has the higher fiber content: fruits or meat, cornflakes or oatmeal, popcorn or pretzels. They were also asked to identify which foods contain more cholesterol: liver or T-bone steak, butter or margarine, skim or whole milk. Other questions probed knowledge about different kinds of fat, the types of foods that contain cholesterol, and the relationship between fat and cholesterol.

Respondents identified the correct answer to some of the comparisons more easily than others. For example, over 90 percent correctly identified whole-wheat bread as containing more fiber than white bread, but only 56 percent knew that kidney beans contained more fiber than lettuce (table 1). Likewise, virtually everyone (95 percent) knew that skim milk has less cholesterol than whole milk, but only 52 percent correctly identified liver as containing more cholesterol than a T-bone steak. The same held true for the questions concerning fat content. Most knew that ice cream contained more fat than sherbet, and that fried chicken was higher in fat than roasted chicken, but far fewer knew that a porterhouse steak contained more fat than does a round steak. When asked what kind of fat (saturated or polyunsaturated) is more likely to be a liquid rather than a solid, only 30 percent of respondents correctly identified polyunsaturated. Less than 40 percent of the respondents knew that cholesterol is found only in animal products.

Diet and Health

The measure of awareness of diet-health problems is based on answers to eight questions from the DHKS in the general form: Have you heard about any health problems that might be related to how much of a particular nutrient or food component a person eats?

About 85 percent of the respondents indicated that they had heard of health problems associated with salt, but less than 50 percent said the same for fiber and iron (table 2). We constructed the diet-health awareness measure by adding together the positive responses for each of the eight questions. We use positive, not correct, responses because a belief that an association exists between a health problem and food component or nutrient is often all that is required to provide motivation for change.

Comparing Nutrition Knowledge with HEI Scores

USDA rates HEI scores of greater than 80 as "Good," scores of 51-80 as Needs Improvement," and scores below 51 as "Poor." We found that higher HEI scores are clearly associated with increased knowledge about the nutrient content of foods as well as about diet-health awareness (table 3). For example, individuals with Good scores answered an average of two more questions correctly about nutrient content than did people with Poor HEI scores.

Age appears to be strongly associated with higher HEI scores. On average, people over age 69 scored 10 points higher than those under age 30. However, there was no clear association between age and nutrient knowledge or diet-health awareness. On the other hand, women had higher HEI scores than men and higher nutrient knowledge and diet-health awareness levels.

Race and ethnicity appear to influence HEI scores as well as nutrient knowledge and awareness. Whites had higher HEI scores on average than Blacks, but the scores of Hispanics and non-Hispanics were virtually identical. Non-Hispanics' nutrient-content knowledge and diet-health awareness scores were higher than Hispanics'.

Higher education and incomes were correlated with more knowledge of the nutrient content of foods, more awareness of diet-health problems, and to higher HEI scores. Smokers had lower HEI scores than nonsmokers and slightly

Table 2
Majority Are Aware of Health Problems Related to Nutrients, Except Fiber and Iron

Question	Respondents answered—Yes	No
	Percent	
Have you heard about any health problems that might be related to how much...		
Fat a person eats?	71.3	28.7
Saturated fat a person eats?	58.6	41.4
Fiber a person eats?	48.8	51.2
Salt a person eats?	84.7	15.3
Calcium a person eats?	59.3	40.7
Cholesterol a person eats?	81.7	18.3
Sugar a person eats?	79.6	20.4
Iron a person eats?	47.5	52.5

Source: 1989-90 Diet Health Knowledge Survey, USDA.

lower knowledge and awareness scores.

Information Differences and Sociodemographic Characteristics

Nutrient-content knowledge, diet-health awareness, and HEI clearly differ according to an individual's sociodemographic background, but what underlies these differences? Are the differences in diet quality among sociodemographic groups due to differences in health and nutrition knowledge or to differences in tastes and preferences?

We undertook a comprehensive multivariate statistical analysis to separate the influence of these two factors and to determine the effects of knowledge on diet quality. We also examine the impact of a single personal or household characteristic on a person's nutrient-content knowledge level when the other characteristics are held equal.

If we compare two people with similar sociodemographic characteristics (same sex, race, income level, and so forth) except that one had a postgraduate education while the

Table 3
Healthy Eating Index Increases With Age, Education, and Household Income

Respondent profile	Nutrient-content knowledge	Diet-health awareness	Healthy Eating Index (HEI)
	Number of correct answers		*Mean HEI score*
HEI:			
Less than 51	14.41	4.71	44.99
51-80	15.45	5.33	64.79
Greater than 80	16.55	6.04	88.09
Education:			
Less than high school	14.10	4.53	62.57
High school	15.56	5.20	62.97
More than high school	16.56	6.21	66.67
Income per capita:			
$3,800 or less	14.28	4.72	59.52
$3,801-5,400	14.69	4.74	63.47
$5,401-10,200	15.30	5.18	64.52
$10,201 or more	16.57	6.06	66.83
Age:			
Under 30	15.09	4.84	59.28
31-49	15.67	5.64	61.51
50-69	15.68	5.44	67.17
Over 69	14.74	4.84	69.33
Gender:			
Male	14.75	4.95	60.59
Female	15.56	5.39	64.79
Race:			
White	15.74	5.49	64.78
Black	13.76	4.41	59.66
Other	14.12	4.47	63.56
Ethnicity:			
Non-Hispanic	15.55	5.37	64.04
Hispanic	13.56	4.60	64.11
Smoking:			
Smoker	15.04	4.93	58.63
Nonsmoker	15.55	5.45	65.98

Table 4
Nutrition Knowledge Increases Steadily With the Level of Education

Personal characteristic	Additional nutrient-content questions answered correctly
Level of education (compared to those with less than a high-school education):	
High school	.60
Some college	1.13
College	1.74
Postgraduate	2.17
For an additional year of age	0
Female (compared to male)	1.10
Race (compared to Whites):	
Black	-.97
Other race	-1.40
Hispanic (compared to non-Hispanic)	-1.40
Employment status (compared to those employed full time):	
Employed part time	.33
Not employed	0
For an additional unit of body mass index[1]	0
Smoker (compared to nonsmoker)	-.21
For an additional $10,000 in household income	.25

Note: [1]Body mass index is the ratio of a person's weight in kilograms to the square of height in meters.

other did not complete high school, the more educated person generally answers correctly two more nutrient-content questions than does the other person (table 4).

Similarly, all things being equal, women correctly answer one more nutrition-knowledge question than men. On the other hand, other things equal, a person's age or weight relative to height (body mass index) has no influence on nutrition knowledge.

A person's race and ethnicity also play a role in his or her nutrition knowledge. Blacks and people from other non-White racial groups have lower nutrition knowledge than Whites, other things being equal. Hispanics tend to have lower nutrition knowledge than non-Hispanics.

Diet Quality Differences Could Be Due to Information or Taste Differences

Personal and household characteristics help shape people's taste and preferences and nutrition knowledge levels, which in turn help determine diet quality. It is important for the effective design and execution of nutrition-education efforts that we isolate the characteristics that determine nutrition-knowledge levels from those primarily influencing tastes, as well as separate the influence of those that affect both information and tastes.

Assume that John and Bob have identical sociodemographic characteristics, including their knowledge of nutrition, with one exception: John never completed high school but Bob went on to postgraduate studies. Our statistical models would predict that John's HEI is over 6 points higher than Bob's (table 5). At first glance, this is a surprising result. But with a few additional pieces of information, the story falls in place. Recall that in this scenario, we are assuming that despite their different educational levels, John and Bob have the same level of nutrition knowledge. Therefore, the effect of Bob's higher education level on his diet may be associated with his preference for convenience foods, dining out, and more costly food items, such as prime rib. This in turn leads to a lower HEI for Bob than for John.

However, from what we learned from table 4, more highly educated people tend to have more nutrition knowledge than do those with less education. Using Bob and John as examples, let's now assume that since Bob has more education he also has more nutrition knowledge than John. The result is vastly different—Bob's HEI is now 5.5 points higher than John's (table 5). Bob's higher education is associated with higher levels of nutrition information, which more than offsets his preferences for dining out and convenience. The result is a higher HEI score than the less-educated John.

We also find that men and women, if identical in all other sociodemographic and knowledge respects, have virtually the same HEI's. But if we assume that women have more nutrition knowledge, their HEI's are about 5 points higher than for men. A particularly dramatic example occurs for Hispanics. Suppose we have two people, one Hispanic the other not, but otherwise possessing identical sociodemographic characteristics. The Hispanic has an HEI score almost 9

points higher than the non-Hispanic. However, if we allow the levels of nutrition information to be higher for the non-Hispanic, as our research finds, then the Hispanic now has an HEI only about 2 points higher than the non-Hispanic. This result assumes that any differences in answers given by respondents are due to knowledge and not language differences.

Another surprising result occurs when we examine the relationship between income and diet quality. If we take two people with identical characteristics except one has a higher income, the wealthier person has a lower HEI. This is due to higher incomes being associated with preferences for convenience foods, dining out, and more expensive, fat-rich foods, all of which contribute to a lower HEI. However, we know that income is also associated with higher nutrition-knowledge levels. When this is taken into account, higher income people actually have a slightly higher HEI than do their lower income counterparts.

In contrast to income, education, and gender effects, however, the effects of age, body mass, and smoking are almost entirely due to different tastes and preferences associated with these characteristics and not due to any informational differences.

Diet quality tends to improve with age. However, this effect is entirely due to changing tastes, since age has no effect on nutrition information once other sociodemographic effects are taken into account (table 4). Similarly, smokers are nearly as informed about health and nutrition as nonsmokers, yet smokers tend to prefer a less healthful diet and thus tend to have a lower HEI. Diet quality deteriorates for those with higher body mass, even though they are as equally informed about health and nutrition as people with a lower body mass index. Another important characteristic influencing a person's HEI is labor force participation. As the estimates for employment status in tables 4 and 5 show, this influence is largely due to knowledge differences.

Table 5
When Knowledge Is Factored Out, a More Educated Person May Have a Lower HEI Than a Less Educated Person

Personal characteristic	Change in HEI score when two individuals have the same level of knowledge	Change in HEI score when two individuals have different levels of knowledge
Level of education (compared to those with less than a high-school education):		
High school	-2.15	1.13
Some college	-2.31	3.89
College	-4.10	5.22
Postgraduate	-6.17	5.53
For an additional year of age	.18	.19
Female (compared to male)	0	4.99
Race (compared to Whites):		
Black	3.40	-1.61
Other race	6.64	0
Hispanic (compared to non-Hispanic)	8.90	1.89
Employment status (compared to those employed full time):		
Employed part time	0	1.74
Not employed	0	1.19
For an additional unit of body mass index[1]	-.20	-.13
Smoker (compared to nonsmoker)	-3.48	-4.59
For an additional $10,000 in household income[2]	-.61	.64

Note: [1]Body mass index is the ratio of a person's weight in kilograms to the square of height in meters.

A Last Look: Some New Findings

Many regard information and knowledge as the keys that will unlock the door to better diets and in turn better health, longer lives, and children with improved cognitive and learning abilities. We verify some of these observations with the finding that more nutrition knowledge leads to higher HEI scores.

Nutrition information affects overall diet quality, even after controlling for individual differences in a host of personal and household characteristics, including income, education, age, gender, race, ethnicity, smoking behavior, and body mass. The positive effects of higher incomes and education levels on diet quality are due to the greater nutrition knowledge that wealthier, more educated people possess. If this informational advantage were to disappear, for example through nutrition-education targeted to low-income individuals or that starts early in childhood, then those with greater incomes or education may in fact have diets that are no better, or possibly poorer, than would people with lower incomes or education. This is because people with higher incomes or education may have a greater preference for convenience foods and food away from home that are often less nutritious.

The strong link between nutrition knowledge and diet quality suggests a continued role for nutrition-education efforts to close the persistent gap between actual and healthful diets.

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