

## **Eating a Healthy Diet: Is Cost a Major Factor?**

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**ABSTRACT**

We examine the association between food expenditure and overall diet quality using a model where we assumed dietary quality is a function of health conditions, life style choices, total food expenditures, and socio-economic status. We use cross-sectional data from the National Health and Nutrition Examination Survey (NHANES) 2001-02 and the U.S. Department of Agriculture (USDA)'s Center for Nutrition Policy and Promotion Food Prices Database. Diet quality is measured using the USDA Healthy Eating Index-2005. Our findings suggest that there is no statistically significant association between total diet quality and diet cost for men, but a small association for women. Compared with diet cost, health conditions, life style choices, and socio-economic status play an important role in determining diet quality.

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### **Introduction**

The impact of diet on health, including the reduced risk of chronic diseases, such as coronary heart disease, osteoporosis, and some types of cancer, is summarized in the Report of the Dietary Guidelines Advisory Committee on the Dietary Guidelines for Americans, 2005 (Dietary Guidelines Advisory Committee, 2004). This extensive report summarizes the scientific research which forms the basis of the 2005 Dietary Guidelines (U. S. Department of Health and Human Services and U. S. Department of Agriculture, 2005). While the Dietary Guidelines are intended to provide guidance to persons living in the United States and set US policy for food and nutrition programs, the scientific information detailed in the report applies well beyond the US borders, particularly to countries such as Canada who have adopted parts or portions of the US dietary guidance system. For example, the report of the 2005 Dietary Guidelines Advisory Committee was part of the evidence base for Canada's Food Guide (Katamay et al., 2007).

However, most individuals consume diets that are considered far from optimal to impact health. According to a review by Fransen and Ocke, diet quality scoring systems have been developed for use in several countries, including Australia, Belgium, Burkina Faso, Canada, China, Denmark, France, Germany, and the United States (Fransen and Ocke, 2008). Each suggests areas for diet improvement. The US Department of Agriculture (USDA) measures diet quality by using the Healthy Eating Index-2005 (HEI-2005). According to this index Americans, regardless of income level, could benefit from dietary improvement by increasing intakes of fruits, vegetables, whole grains, and fat-free or

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low-fat milk; choosing more nutrient-dense forms of foods—that is food low in solid fats and free of added sugars; and decreasing their salt intake (Guenther et al., 2008a).

Previous research has examined factors associated with Americans' suboptimal diet (Basiotis et al., 1998, Glanz et al., 1998, McAllister et al., 1994, Stewart et al., 2003, Variyam et al., 2000). Some factors have to do with how we choose our foods. Glanz and colleagues (Glanz et al., 1998) find that taste and convenience are the most important factors in choosing foods. Convenience was especially important for younger shoppers and low-income shoppers. Other studies find that individuals choose healthier diets as they get older (Variyam et al., 2000), particularly persons over 65 (Stewart et al., 2003). Individuals with a higher education are also more likely to choose a healthier diet (Stewart et al., 2003), though higher nutrition knowledge is also important (Variyam et al., 2000). While education may indicate a person's ability to better understand nutrition advice, it also demonstrates that individuals are willing to forgo short term benefits of immediate wage earnings for longer term gains (Ruhm, 2000). This may indicate that those with a higher education are willing to forgo immediate taste and convenience in favor of good health. Arnade and Gopinath (2006) using household purchase data over several years, found that more educated households are more quick to respond to cumulative fat purchases; that is they reduce purchases of the more fatty meat, poultry, fish and dairy products in favor of leaner forms, until a certain threshold is reached (Arnade and Gopinath, 2006).

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Although the cost of food has also received considerable attention because cost influences how and what people choose to eat (Darmon et al., 2002, Glanz et al., 1998, McAllister et al., 1994, Mitchell et al., 2000, Schroder et al., 2006), results regarding diet and food costs have been mixed. A French study reported a relationship between higher food costs and an increase in nutrient density (Darmon et al., 2002). However, the study was based on only 73 commonly consumed foods, leaving some room for bias if the list had less expensive energy dense foods and more expensive nutrient dense foods.

Similarly, a Spanish study of 166 foods reported that diet quality was positively associated with the cost of food (Schroder et al., 2006). Cost was the third most important influence on food choice, after taste and convenience in a survey in which Americans were asked why they ate certain foods (Glanz et al., 1998). Another study concluded that although food costs are perceived to be a barrier to the adoption of a low-fat diet there was no difference in food costs among children adhering to such a diet (Mitchell et al., 2000). Since cost is raised as a barrier to healthy eating, income has also been investigated. The non-poor spend more on fruits and vegetables than the poor (Stewart et al., 2003). However, in a study linking state and local economic indicators to the U.S. Center for Disease Control and Prevention's on-going telephone health survey (the Behavioral Risk Factor Surveillance System (BRFSS)) over several years, Ruhm found that during times when state unemployment rates are high, there was a reported decrease in dietary fat consumption and an increase in exercise (Ruhm, 2000).

Researchers have also addressed the question of how households and individuals could make healthier food choices without spending more on food. A costing of diets that

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complied with nutrition recommendations showed that healthful eating could reduce the cost of food for most people (McAllister et al., 1994). In a one-year family-based treatment of children at risk of obesity, researchers found that as the household shifted to healthier options, the household actually spent less on food (Raynor et al., 2002). The US Department of Agriculture (USDA) estimates the cost of food at home at four expenditure levels, assuming that individuals meet the Dietary Guidelines for Americans (Carlson et al., 2007a, Carlson et al., 2007b) and finds that consumers can eat a healthy diet for the same as they are presently spending or less. Finally, a recent analysis by the USDA suggests that cost comparisons should be made based on how much it costs to meet key dietary recommendations. Using this method, many fruits and vegetables are quite competitive in price to the cost of common portions of energy-dense foods such as many processed salty snack foods (Golan et al., 2008).

In summary, previous research finds that, taste, convenience, education, age, and cost can influence an individual or household's decisions to consume a healthy diet. Research has also been conducted to demonstrate how a healthy diet can be affordable. However, a rigorous examination of the association between diet quality and total food expenditure using a 24-hour dietary recall, has not been undertaken in the U.S, primarily because data linking diet quality, food expenses, and information on confounding factors have not been available until recently. This study tests the hypothesis that consumers who spend more on their food tend to consume healthier diets, leading to higher total scores as measured by the Healthy Eating Index-2005 (HEI-2005). In addition, the current study

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also examines the impact of total food expenditure on the individual components that constitute the HEI-2005.

### **Methods**

#### Data

Data from the National Health and Nutrition Examination Survey (NHANES) 2001-02 were used for this study. NHANES collects information about participants' food consumption (in this paper food consumption refers to food that is actually eaten, not food that is purchased and potentially thrown out), demographic and socioeconomic characteristics, and health information obtained during a four-hour medical examination in a mobile examination center. As part of this exam, an interviewer collects a 24-hour dietary recall. Information about dietary intake for individuals 12 years and older was self-reported. USDA later calculates the nutrient content of foods that were reported consumed by NHANES participants. NHANES 2001-02 is a complex, multistage probability sample of the civilian non-institutionalized population of the United States, and consists of a sampling of individuals of all ages. We investigate all adults ages 20 and over with a reliable dietary recall, resulting in a final sample of 4,252. More information on the NHANES studies can be found elsewhere (Centers for Disease Control and Prevention and U. S. Department of Agriculture, 2004).

The NHANES does not collect information on food prices or expenditures for foods consumed. USDA's Center for Nutrition Policy and Promotion (CNPP) recently estimated the national average prices of foods reported consumed in NHANES and

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created the 2001-02 CNPP Food Prices Database by using national average food price data from the 2001-02 Nielsen Consumer Homescan Panel (Nielsen, 2005). This panel contains the prices paid for food items by 16,821 households, selected and weighted to reflect the U.S. population. The food purchases of these households are collected over a 1-year period. Foods purchased at supermarkets, convenience stores, warehouse clubs, mass merchandisers, drug stores, and farmer's markets are included (Carlson et al., 2008). The CNPP Food Prices Database was originally created to estimate food costs for the USDA Food Plans (Carlson et al., 2007a). It contains a price for every food item reported consumed in NHANES 2001-02 and assumes that the food was prepared at home. The database includes many convenience items, such as frozen fruits and vegetables, bottled sauces, prepared soups, box meals, and frozen and shelf-stable entrees. The database also accounts for the food purchased but lost in either preparation (peels, seeds, shells, bones and skins) or through cooking (moisture loss) and gives the cost of the food in its consumed form.

### Model and Estimation

As suggested by the literature review, we assume that an individual's diet quality is a function of food expenditure, life style choices related to health and food, socio-economic factors, and health factors. In this section we elaborate on the exact variables chosen to represent each component.

The dependent variable, diet quality, was measured by each adult's HEI-2005 total score for the 1 day reported and calculated from NHANES 2001-02. We choose this measure

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over other measurements because it was developed for current dietary recommendations in the United States and is used by USDA to monitor changes in food consumption patterns. The HEI-2005 was published in 2006 to incorporate the 2005 Dietary Guidelines for Americans (U. S. Department of Health and Human Services and U. S. Department of Agriculture, 2005) and the recommendations found in MyPyramid (U. S. Department of Agriculture, 2005), which was released in 2005. The HEI-2005 consists of 12 components and has a maximum total score of 100 points. A higher score indicates a higher diet quality. There are 12 components in the HEI-2005: Total Fruits; Whole Fruits (i.e., forms other than juice); Total Vegetables; Dark Green and Orange Vegetables and Legumes; Total Grains; Whole Grains; Milk, which includes soy beverages; Meat and Beans, which includes meat, poultry, fish, eggs, soybean products other than beverages, nuts, seeds, and legumes; Oils (non-hydrogenated vegetable oils and oils in fish, nuts, and seeds); Saturated Fat; Sodium; and Calories from Solid fats, Alcoholic beverages, and Added Sugars (SoFAAS). Since a higher score indicates higher diet quality, higher component scores for Saturated Fat, Sodium, and SoFAAS represents lower consumption, while a higher score for the other components represent higher consumption up to the recommended level. Maximum scores for the components range from 5 to 20. For more information on the HEI-2005 components and scoring system and its measurement properties, see Guenther et al., 2008b, Guenther et al., 2008c.

Food expenditure was measured by the total cost of all foods reported as consumed by the respondents on the recall day. The cost of foods reported as consumed was assessed using each person's 1-day food consumption data and the 2001-02 CNPP Food Prices

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Database. As previously stated, food was priced assuming it was prepared at home. NHANES 2001-02 does not provide information on where the food was purchased, and even if we knew the food purchase location, comprehensive data on the cost of food consumed at restaurants does not exist. In addition, NHANES does not publically release geographic information so food prices are estimated using national average food prices. These are two limitations of the data, but these are the best available data sources for food prices. We also include food cost squared in the model to account for an expected curvi-linear relationship between expenditure and diet quality.

Life style choices related to health and food are represented by variables on whether the respondent smoked cigarettes at the time of the interview, ate breakfast on the recall day, ate lunch on the recall day, ate dinner on the recall day, ate a snack on the recall day, day of week the food was reported consumed (weekend versus weekday with Fridays being included as a weekend day), and the percentage of total calories consumed at home on the dietary recall day. As mentioned previously, this is not a representation of the foods prepared at home, but does nevertheless represent a food-related behavior: does the individual consume differently while “on the go” or at home?

Due to privacy concerns related to the health data, socio-economic data are somewhat limited in NHANES compared to other publically available data sources. We include the respondent’s before-tax household income, expressed as a percentage of the U.S. poverty threshold; that is, the higher this figure, the higher the per capita income of the household. Other socio-economic variables included were the respondent’s highest level

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of education (less than high school degree, high school degree, or more than high school degree); age (including age squared to account for the expected curvilinear relationship), race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic of any race, or other race/ethnicity such as Asian, Pacific Islander, or American Indian); and whether he or she was single (including divorced and widowed) or married (or living as married).

Health factors included are those related to situations that might bring the individual in more frequent discussions about diet with health care professionals. Two of these situations are obesity, and for women, pregnancy or lactation status. For obesity, we use a ratio of the individual's waist circumference to the healthy weight cutoff point, rather than the more common body mass index (BMI). This ratio was included because a high waist circumference is associated with an increased risk of complications in patients with a body mass index (BMI) between 25 and 34.9 (classified as overweight, but not obese). Furthermore, in obese patients with metabolic complications (such as cardio-vascular disease (CVD), hypertension, and type 2 diabetes), changes in waist-circumference are useful predictors of changes in CVD risk factors (Centers for Disease Control and Prevention, 2007). The waist circumference cutoff point for a healthy weight individual is 102 centimeters for men and 88 centimeters for women (Bray, 2004). Using this cutoff as the denominator, a ratio of less than 1.0 is considered a healthy weight while a ratio greater than 1.0 indicates the individual is overweight or obese.

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The other health factor, pregnancy and lactation status, is included because there is a higher probability that these women were receiving specific nutrition education and had a more immediate incentive (a healthy baby) to eat a healthy diet than those who are not pregnant or lactating. We use self-reported pregnancy status since women who do not know that they are pregnant are less likely to alter their diet for the health of their baby.

To test our model, we used a linear regression model run separately for women and men, since preliminary analysis indicated differences in diet quality by gender for several variables in the analysis. Statistical weights in NHANES were used and were adjusted by built-in survey regression models in Stata (version 9) to account for subjects in the NHANES excluded in the current study. These methods are described in the Stata reference manual (Stata Corporation, 2003). Appropriate controls for the survey design were also applied. Independent variables were deemed statistically significant at the 0.05 level.

The percent of food consumed at home may be considered an endogenous variable, since the decision to eat at home may be part of the decision to eat a healthy diet. Using endogenous variables as independent variables would be a violation of Ordinary Least Squares (OLS) analysis and is often corrected using instrumental variables. One test for endogeneity is to use instrumental variables to estimate a Hausmann test. Normally one would look for instruments that are good predictors of the percent of food consumed at home, but poor predictors of diet quality. However, variables such as cooking ability,

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proximity to a grocery store, and available time are not available in this data set. Instead, this study uses the Lewbel method of moments (Lewbel, 1997), and adopted by Park and Davis (Park and Davis, 2001) and Abdulai and Aubert (Abdulai and Aubert, 2004).

Briefly, this method uses the means and variances of the dependent variable (in this case the HEI-2005 score) and the means and variances of the continuous variables to calculate a set of instruments. Applying Lewbel to this study, the variables for income and household size (poverty-income ratio), age, waist circumference, food expenditure, and percent of food consumed at home are all continuous variables, and the respective means and variances are used to estimate the instruments. The Hausmann test did not indicate that the percent of calories consumed at home is endogenous, so we proceeded with the OLS regressions.

### **Results**

Figure one shows a scatter plot of the data for HEI score and daily food expenditure. The figure shows that there is a range of expenditures and HEI scores for adults. In fact, daily expenditures for adults on food range from \$0.22 to \$36.76, with a weighted mean of \$4.11 for women and \$6.10 for adults. HEI scores range from 13 to 94 for adults, with a weighted mean of 52.9 for women and 49.3 for men. Figure one does not suggest an obvious relationship between expenditure and diet quality.

The multivariate regression analysis described above does suggest a slight relationship for women, but not for men. For women, a 1-dollar increase in diet cost was associated with a 1-point increase in their total HEI-2005 score, when all other factors are

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considered. A 1-dollar increase in women's daily diet cost represents about 25 percent of total daily diet cost; whereas, a point increase in their HEI-2005 scores represents only a very small improvement in diet quality. This indicates a very small nutritional gain for each dollar spent.

For both women and men, other factors have a significant relationship with diet quality; and for women, many of these factors have a greater degree of association with diet quality than does a 1-dollar per day increase in diet cost. Awareness of these factors should assist nutrition educators in developing and targeting their programs. We particularly focus on the life style choices (other than smoking) since some of these might be easier to change. For example, eating breakfast and lunch, rather than skipping them improved diet quality (about 3 points for each meal). Previous research has also supported the positive association of consuming breakfast with diet quality (Morgan, 1986). The negative association between the percent of calories consumed away from home and diet quality is not surprising. Food consumed away from home is more likely to be foods from fast-food establishments, which tend to be less healthful (Lin et al., 1999a, Lin et al., 1999b), than foods reported consumed at home. Also, if the food was purchased in a store, but not consumed at home, it is more likely to be a convenience food with less nutritional value. Scores were 1 point (women) to 2 points (men) lower on Friday, Saturday, or Sunday than Monday through Thursday.

Being a current smoker was associated with significantly lower HEI-2005 scores for both women and men (about 6 points for women and 5 points for men) compared to

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nonsmokers. It is not surprising that smoking was associated with lower diet quality. It seems that smokers engage in other less than healthful lifestyles, particularly with regards to food consumption. Economic theory suggests that smokers are unwilling to forgo smoking for long term health, indicating a shorter time horizon (Huston and Finke, 2003). Nutritionists should be aware that clients who smoke may need more immediate satisfaction from an improved diet quality than long term health.

In addition to life style choices, health factors are related to diet quality. The ratio of waist circumference to the cutoff for what is considered healthy was significantly and negatively associated with HEI-2005 scores for women and men. A 1-unit increase in the ratio (for women going from 88 to 176 centimeters and for men going from 102 to 204 centimeters) was associated with about a 5-point decrease in an individual's 1-day HEI-2005 score. Being pregnant or lactating was associated with a 3-point higher HEI-2005 score for women. Pregnant or lactating women may be more likely to receive information and counseling on what constitutes a good diet, such as through the Women, Infants, and Children Feeding Program (WIC). These women may also be more concerned about health at the time of the data collection than other women were.

Finally, socio-economic factors were found to be associated with a higher diet quality. A higher level of education was associated with a higher HEI-2005 score for men. Men with some college education had about 2.5-point higher total HEI-2005 scores than men whose highest level of education was a high school degree. College-educated men may

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have been exposed to more nutritional information or counseling. The fact that these men invested in higher education as opposed to getting a job immediately after high school also indicates a willingness to forgo current earnings in order to earn more in the future (Huston and Finke, 2003). This may indicate these men have a longer time horizon and, therefore, a greater tendency to choose a healthier diet. Nutritionists working with those with less education may need to focus on shorter time horizon goals in addition to possible literacy challenges. Age was significantly associated with diet quality for women, but not for men. A 1-year increase in a women's age is associated with a 0.3-point increase in their HEI-2005 scores. Both women and men of another race/ethnicity such as Asian, Pacific Islander, or American Indian had significantly better HEI-2005 scores (about 4 points for women and 8 points for men) than their non-Hispanic White cohorts. Hispanic men also had significantly higher HEI-2005 scores (4 points) than non-Hispanic White men. The finding that Hispanic men had a better diet than non-Hispanic White men has been observed previously. The diets of Mexican Americans tend to be better than other ethnic groups, especially with regard to fruit consumption (Basiotis et al., 2002).

It is equally important to note the variables not associated with overall diet quality. Unlike previous research described in the introduction, household income, as represented by the poverty-income ratio, was not significantly associated with diet quality for either women or men. This is surprising since the popular conception is that healthy diets cost more and therefore, only higher income people can afford such diets. This previous

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research did not control for food expenditure as this study did; hence, income may have been capturing the influence of food expenditure.

### Limitations and Conclusions

The main strength of this study and what distinguishes it from previous studies is the incorporation of a reasonable estimate of an individual's food expenditure into the research model. In addition, since we used a U.S. national sample, these results are generalizable to the U.S. adult population. Nonetheless, this study has its limitations. One such drawback is the basing of our analysis on one 24-hour recall per NHANES participant, which may not be a reliable estimate of his or her usual intake (Subar et al., 2003), and this may also pose a limitation. However, the expenditure is also based on what the respondents report eating on 1 day and thus represents the cost of the diet to which the HEI-2005 score was assigned. Another limitation is that some commonly used variables in studies of diet, such as number of children, geographic region, and employment status are not included in the public release version of NHANES and not included in this research. Lastly, CNPP's Food Prices Database relies on average national prices when assigning costs to food. Food prices faced by individuals are likely to be different from national averages, although the extent of this difference is not known for each individual.

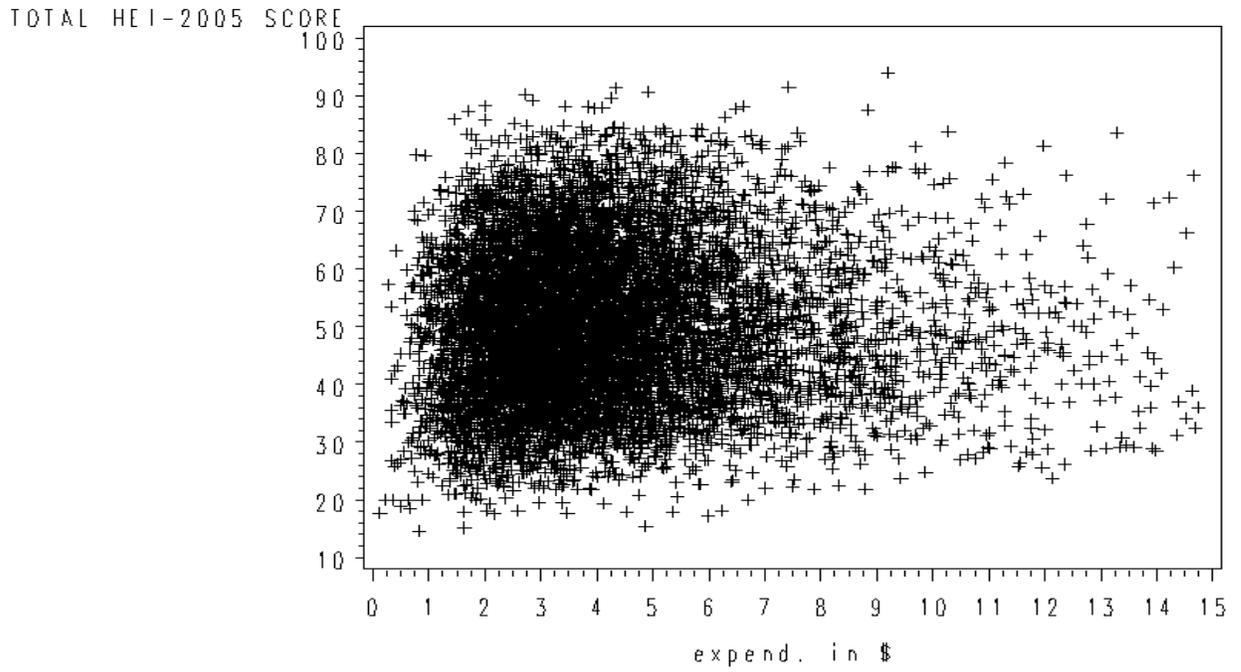
Overall, this study undertook a rigorous examination of the association between diet quality and total food expenditure in the U.S using national data not previously available.

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Economic factors, namely diet cost and household income were found to play a minor or nonsignificant role in achieving a higher diet quality. Factors having a significant association on diet quality for men include education, race/ethnicity, smoking status, eating breakfast as well as lunch, day of week, percent of calories consumed at home, and the ratio of waist circumference to healthy weight cut off point. Factors having a significant association with diet quality for women include, age, race/ethnicity, smoking status, eating breakfast as well as lunch, day of week, percent of calories consumed at home, and being pregnant or lactating. For women, many of these factors have a greater degree of association with diet quality than does diet cost.

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Figure One: HEI Score vs. Expenditure, Adults



Note: Data from the 2001-02 National Health and Nutrition Examination Survey and 2001-02 CNPP Food Prices Database.

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