# THE IMPACT OF ECONOMIC FACTORS ON CONSUMER HEALTH

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Selected Paper Presented at the WAEA Annual Meeting

Portland, Oregon, July 29- August 1, 2007



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## ABSTRACT

This study estimates the relationship between economic factors and consumer health. The results show that increasing prices of food away from home are associated with decreasing the probability of risk factors and health conditions, which emphasizes the need to differ between multiple food types in health demand analysis.

## INTRODUCTION

High blood pressure[1] and diabetes are a major public health concern. During the 1990s, the prevalence of these risk factors and health conditions increased and the trend is expected to rise. High blood pressure currently affects more than 30% of the U.S. adult population, while about 6% of the U.S. population has been diagnosed with diabetes; 90% of which are Type II diabetes cases. High blood pressure and diabetes contribute to circulatory diseases, such as heart attacks, heart failure, and stroke. Circulatory diseases are the number one cause of death in the U.S. The estimated direct and indirect costs of circulatory diseases in the United States for 2007 are $432 billion (American Heart Association, 2007; The North American Association for the Study of Obesity (NAASO), 2007).

In order to determine the effects of health policy interventions, it is important to determine factors affecting people's health. Health is influenced by individual choices, because people can exercise and choose proper diets. However, economic variables, such as wages, food prices, and income influence individual choices of these health inputs. A number of previous studies (e.g. Jacobson and Brownell, 2000; Chen et al., 2002) have identified the need for research that evaluates whether changes in economic factors influence consumer health. However, due to the difficulty of obtaining a data set that contains demographic and economic information, only a few studies have focused on this topic and none has considered risk factors as well as health conditions (e.g. Chen et al., 2002; Lakdawalla, Philipson, and Bhattacharya, 2005; Schroeter, Lusk, and Tyner, 2007). In addition, two studies used data sets that are more than 10 years old; a time period which does not fully encompass the recent increase in these risk factors and health conditions. Most recently, Schroeter, Lusk, and Tyner (2007) demonstrated a

[1] High blood pressure is determined by a systolic blood pressure ≥140 (American Heart Organization, 2007).

case where a tax on food away from home, a food intake category blamed for much of the rise in obesity, could lead to an increase in body weight. Thus, this finding suggests the importance to differ between multiple food types in health demand analysis.

The objectives of this study are to identify the relationship between food prices, wages, and income on the most common obesity-related health risks and health conditions: 1) high blood pressure and high blood cholesterol level, 2) circulatory diseases, such as coronary heart disease or angina, stroke, and heart attack; 3) diabetes. The results of this study identify conditions under which price, wage, and income changes affect these health risks or health conditions. Knowledge of the relationships between economic constraints, demographic characteristics, lifestyle, and health risks would permit decision makers to evaluate policies and their potential for success in obesity prevention.

## BACKGROUND

Several studies have identified the need for research to evaluate whether and to what extent price and income changes influence consumer health issues (e.g. Jacobson and Brownell, 2000), but few studies have combined a solid theoretical framework with a subsequent empirical analysis (Chen et al., 2002; Lakdawalla, Philipson, and Bhattacharya, 2005; Schroeter, Lusk, and Tyner, 2007; Chou, Grossman, and Saffer, 2004).

Chen et al. (2002) show that individual choices of nutrient intake, exercise, and medication are influenced by exogenous food prices, wages, and income. Using these exogenous variables as instruments for endogenous behavior shows that sodium significantly decreases blood pressure, which contradicts initial expectations. This finding reinforces the idea the

economic choice and health status are interrelated. Furthermore, the study emphasizes that prices, wages, and income can effectively be used to determine the production of health.

Focusing on micronutrient deficiencies, Lakdawalla, Philipson, and Bhattacharya (2005) augment the 1988-1994 National Health and Nutrition Examination Survey (NHANES) with local food prices of 24 items purchased for home consumption. They find that increasing food at home prices may contribute to micronutrient deficiencies. However, the researchers do not consider the effect of changes in the price of food away from home.

Chou, Grossman, and Saffer (2004) merge micro-level data from the 1984-1999 Behavioral Risk Factor Surveillance System with various state-level food prices and the number of full-service and fast-food restaurants. The study suggests that the absolute effect of the food at home price on body weight is less than the effect of food away from home price.

Schroeter, Lusk and Tyner (2007) also differentiate between food at home and food away from home consumption, but additionally use beverage price information. Using energy accounting, they identify the effect of price and income changes on body weight. They show that subsidizing diet soft drinks or taxing caloric soft drinks would efficiently decrease body weights.

This study expands on previous research in a number of ways. First, it focuses on the most common health risk factors and health conditions, a combination which has not been considered in previous studies. Second, this study differs between multiple food prices at their point of purchase, i.e. food at home vs. food away from home. As will subsequently be seen, this differentiation has a significant effect on the outcome of the dependent variables. Third, this study uses data from the 2003 Behavioral Risk Factor Surveillance System (BRFSS) and 2003 Consumer Price Index (CPI) data, while two of the preceding studies employed data from 1976-

1978, and 1988-1994, respectively (Chen et al. 2002; Lakdawalla, Philipson, and Bhattacharya, 2005). Lastly, many health conditions are dichotomous events – either you have diabetes or you do not. As such, this study will more importantly focus on factors affecting the *likelihood* of health risks and health conditions. Chen et al. (2002), focused on establishing a link between economic factors and systolic blood pressure by using multiple regression analysis. Whereas their approach provides information of the effect of explanatory variables on *mean* systolic blood pressure levels, most health experts tend to classify people by "high," "normal," or "low" blood pressure categories. Our approach shows the effects of explanatory variables on the likelihood of having high blood pressure. To this end, this research explores the influence of various variables on the probabilities of health risk factors and the most common health conditions by using a binomial logit model. While controlling for demographic, lifestyle and diet information, the main goal of this study is to determine whether and to what extent food prices, wages, and income contribute to the increase in reported rates of health risk factors and obesity-related health conditions.

## MODEL, DATA AND PROCEDURES

### THEORETICAL MODEL

This study follows the household production theory of health production proposed by Becker (1965) and Grossman (1972). This approach was further developed in Chen et al. (2002) and Schroeter, Lusk, and Tyner (2007). Chen et al. (2002) define that an individual's health function depends on nutrients from food consumption, exercise, and the level of medication consumed [2] Following the approach by Schroeter, Lusk and Tyner (2007), first, consider a simple three-good

[2] In contrast to the approach used by Chen at at. (2002), this study does not include the level of medication consumed.

model example, in which an individual's health $H$ is affected by the quantity of "healthy" ($F^H$) foods consumed, the quantity of "unhealthy" ($F^{UH}$) foods consumed, and the level of exercise ($E$); i.e. $H=H(F^H, F^{UH}, E)$.

Thus, $H$ represents a health production function, where food and exercise are inputs. A person's utility can be written as

(1) $U(H(F^H, F^{UH}, E), F^H, F^{UH}, E, C)$.

which is maximized with subject to a budget constraint

(2) $p_{F^H} F^H + p_{F^{UH}} F^{UH} + p_E E + p_C C = I$,

where $p_{F^i}$ is the price of food type $i$ ($i$=H, UH), $p_E$ is the price of exercise, $p_C$ is the price of all other consumption goods, and $I$ represents income. Given the traditional tradeoff between an hour of labor for leisure-time activities, a price is associated with exercise. This set-up is similar to Philipson and Posner (1999), but their model did not differ between multiple foods.[3] As shown in subsequent analyses, this has important implications for the efficacy of price changes.

Maximizing utility (1) with respect to (w.r.t.) budget constraint (2) results in Marshallian demand curves for high-calorie food, low-calorie food, and exercise. Solving the first order condition creates an optimal health equation $H^*$, which depends on prices of all goods and income

(3) $H^* = H^*(F^{H^*}(p_{F^H}, p_{F^{UH}}, p_C, p_E, I), F^{UH^*}(p_{F^H}, p_{F^{UH}}, p_C, p_E, I), E^*(p_{F^H}, p_{F^{UH}}, p_C, p_E, I))$

where the $^*$ superscript indicates utility maximizing levels. Thus, health is a function of the prices of healthy and unhealthy food, the price of exercise, and income.

[3] Foods that are rich in fats and sugars tend to be high in energy (Drenowski, 1998). The energy released from carbohydrates, protein, and fat can be measured in calories (Whitney Cataldo, and Rolfes, 2002). Foods with higher energy density deliver fewer calories per eating occasion; i.e., more calories per unit weight, than foods with a low energy density (Drenowski, 1998). In this study, energy-dense food will be described as high-calorie food, while food low in energy will be described as low-calorie food. Recent studies suggest that the main reason for overeating is the calorie content in foods rather than their fat content (e.g. Rolls *et al*., 1999).

*Empirical Model*

Health outcomes are often not observed directly, but rather one often observes whether a person has a certain condition (i.e., Diabetes). Let $h_{jr}^{*}$ be a latent variable that represents the extent to which individual *j* living in region *r* is prone to some adverse health consequence. Taking a linear approximation to equation (3), and allowing for differences in health outcomes across people of different demographics, yields the following functional form used in this study

$$
\begin{aligned}
h_{jr}^{*} = {} & \alpha_{0r} + \beta_{1r}\text{African}-\text{American} + \beta_{2r}\text{Hispanic} + \beta_{3r}\text{Asian} + \beta_{4r}\text{Other Ethnicity} + \beta_{5r}\text{Male} + \\
& \beta_{6r}\text{High School Graduate} + \beta_{7r}\text{Some College} + \beta_{8r}\text{College Graduate} + \beta_{9r}\text{Married} + \\
& \beta_{10r}\text{Divorced} + \beta_{11r}\text{Age} + \beta_{12r}\text{Household Income} + \beta_{13r}\text{Food at home price} + \\
& \beta_{14r}\text{Food away from home price} + \beta_{15r}\text{Overtime wage} + \beta_{16r}\text{Moderate physical exercise} + \\
& \beta_{17r}\text{Vigourous physical exercise} + \beta_{18r}\text{Smoking} + \beta_{19r}\text{Employed} + \beta_{20r}\text{South} + \\
& \beta_{21r}\text{Midwest} + \beta_{22r}\text{West} + \varepsilon_{ijr}
\end{aligned} \tag{4}
$$

This study uses three different logit models to assess the impact of food prices, wages, and income on individuals' health. The first model focuses on health risk factors and the dependent variable is the probability of high blood pressure and/or high blood cholesterol. Regarding health conditions, two models estimate the probability of the most common obesity-related health conditions: One model assesses the probability of coronary heart disease or angina, and/or stroke, and/or heart attack and the other models estimates the probability of diabetes.

Let $y_r = 1$ if an individual is positive for a health risk factor (e.g., high blood pressure) or has a health conditions (e.g., diabetes), and let $y_r = 0$ if an individual is negative for the health risk factor or health condition . The probability $y_r = 1$ is the probability that $h_{jr}^{*} > 0$. Let $p_r$ denote the probability that $h_{jr}^{*} > 0$. Now, assuming $y_r$ is distributed according to a Bernoulli distribution, the probability density function is $f(y_r) = p_r^{y_r}(1-p_r)^{1-y_r}$ . Given that the individual decisions are independent, the log-likelihood function based on the observations for *n*

individuals can be written as $\ln L(\beta; y) = \sum_{r=1}^{n} [y_r \ln(p_r) + (1 - y_r) \ln(1 - p_r)]$. Letting the error term in equation (4), $\varepsilon$, be distributed according to a logistic distribution, then $p_r = e^{h_J^* - \varepsilon_R} / (1 + e^{h_J^* - \varepsilon_R})$. A positive (negative) coefficient in the logit analysis means that higher values of the corresponding explanatory variables are linked to an increase (decrease) in the likelihood of the risk factor or the health conditions (Mittelhammer, Judge, and Miller, 2000).

## DATA

This study uses demographic state-level data from the 2003 Behavioral Risk Factor Surveillance System (BRFSS), which is augmented with state-level economic information, given that the BRFSS does not contain any price or wage information (CDC, 2003). Attention has been limited to respondents 18 years and older residing in one of the 51 U.S. states or the District of Columbia.

First, after sorting the BRFSS data by state, it was merged with the 2003 Consumer Price Index (CPI) data published by the U.S. Department of Labor, Bureau of Labor Statistics (DOL/BLS, 2004). This study uses two different CPIs: the CPI of food at home and the CPI of food away from home.[4] The CPI for food away from home encompasses foods such as full service meals and snacks, limited service meals and snacks, food at employee sites and schools, food from vending machines and mobile vendors, and other food away from home. The CPI for food at home consists of cereals and bakery products, meats, poultry, fish, and eggs, dairy and

[4] The definitions for food away from home and food at home are based on the location where the foods are obtained and independent from where they are eaten. Foods purchased at retail stores, such as the grocery store or supermarket is classified as food at home. Foods away from home are obtained from foodservice and entertainment establishments, which are "restaurants," or places with waiter service; "fast food," those self-service and carry-out eating places and cafeterias; "schools," including daycare centers and summer camps; and "others," which include vending machines, community feeding programs, and someone else's home . Meals and snacks that consist of a mixture of both away-from-home and home foods are classified according to the component that contributes the most calories to that particular eating occasion (Lin and Frazão, 1999).

related products, fruit and vegetables, nonalcoholic beverages, and other food at home (DOL/BLS, 2007).

Second, the BRFSS data was merged with wage information, which is drawn from the Occupational Employment Statistics (OES) Survey (DOL/BLS, 2005). Following the BLS practice of using 1.5 for the overtime wage multiple, the wage rate is multiplied by 1.5 to obtain the overtime wage rate (DOL, 2005).

Table 1 shows the descriptions of all variables used in the logit regressions and table 2 shows the descriptive statistics for each of the models. Given that the number of respondents in the BRFSS varies by survey question, the sample sizes change across the three logit analyses. The diabetes model encompassed the largest sample size, while the fewest respondents answered the question regarding the existence of a coronary heart diseases, stroke or heart attack.

Most respondents have high blood pressure and/or high blood cholesterol levels, which is consistent with the common prevalence of these health risk factors. While the average distribution of the independent variables is quite similar across the three models, a few differences should be noted. The sample in the 'coronary heart diseases, stroke or heart attack model' shows a higher number of African-American and lower number of Hispanic respondents. Furthermore, this model shows fewer respondents from the West and Midwest, in favor of a higher number of respondents from the South. Several studies show that African-Americans and Hispanics are more likely to be overweight (e.g. Flegal *et al*., 2002; Galuska *et al*., 1996). The sample in the 'coronary heart diseases, stroke or heart attack model' also depicts the highest BMI, which is consistent with the high prevalence of obesity in the South (Centers for Disease Control and Prevention- National Center for Chronic Disease Prevention and Health Promotion (CDC-NCCDPHP), 2005).

With regard to the economic factors and their expected impact with regard to risk factors and health conditions, previous research shows opposite outcomes when changing the prices of food at home and food away from home. It has been shown that increasing the price of food at home may hurt consumer health status (Lakdawalla, Philipson, and Bhattacharya, 2004; Schroeter, Lusk, and Tyner, 2007). Several studies suggest a link between obesity and eating away from home. The typical food away from home meal is less healthy than home-cooked food, since it is more calorie-dense and contains more total fat, more saturated fat, less calcium, fiber, iron and fewer servings of fruit and vegetables. Regarding food at home consumption, previous studies show that consumers value the nutritional properties of food more, when eating at home compared to when eating out (e.g. Lin and Frazão, 1999, Lin and Frazão, 1997; Jeffery and French, 1998).

Regarding wage rate, the overtime wage rate also serves as an approximation the opportunity cost of time allocated to leisure activities, including exercise, given the basic labor-leisure tradeoff. If a worker trades an hour of labor for leisure-time activities, such as exercise, the *marginal* value of this time represents the opportunity cost of foregone wages from working, which is most accurately represented by the overtime wage. Individuals who work more hours will substitute market goods for their own time in other activities (Lakdawalla and Philipson, 2002; Chou, Grossman, and Saffer, 2004). Thus, increasing the number of hours of work raises the price of active leisure, which raises the likelihood of risk factors and health conditions.

Previous studies have found that the highest rates of obesity occur among population groups with low income levels (e.g. Cutler, Glaeser, and Shapiro, 2003; Chou, Grossman, and Saffer, 2004; Jeffery and French, 1998; Jeffery, French, and Spry, 1991). Being employed

increases income, which may increase the ability live in more affluent areas with more opportunities to exercise or purchase healthier food which is typically higher-priced.

## EMPIRICAL RESULTS

Table 3 shows the results from the three logit regression models and table 4 shows the marginal effects of the independent variables. Interestingly, both types of prices influence the likelihood of high blood pressure and/or high cholesterol level in opposite ways. While increasing food away from home prices decreases high blood pressure and/or high cholesterol level, increasing the price of food at home leads to an increase in these risk factors. Table 4 shows that a $1 increase in the price of food away from home would decrease an individual's high blood pressure and/or high cholesterol level by 0.2%. A $1 increase in the price of food at home would raise the likelihood of these risk factors by 0.1%. Interestingly, overtime wage exhibits a negative sign. Given that these health conditions typically occur at a higher age level, the opportunity cost of leisure may outweigh the increased wage rate. Increasing the overtime wage by $1 would decrease the individual's high blood pressure and/or high blood cholesterol by 0.1%, while a $1,000 increase in income would decrease these risk factors by 0.1%. A higher overtime wage would increase the income level, which would facilitate the ability to purchase healthier food options, that are typically higher priced.

With regard to the circulatory diseases, changing the price of food at home price impacts these health conditions significantly. A $1 increase in the price of food at home makes an individual 0.1% more likely to have circulatory diseases. The price of food away from home does not have a significant influence on circulatory diseases, which means that other factors, not accounted for by the model, may impact these health conditions more significantly. Changing

wages and income would improve these health conditions. A $1 increase in the overtime wage would reduce the likelihood of coronary heart disease, stroke and heart attack by 0.1%. A $1,000 increase in income would decrease the chance for coronary heart disease, stroke and heart attack by 0.1%.

Regarding diabetes, the signs of the food price variables support the findings of the first model and both food price variables are significant. A $1 increase in the price of food at home increases the odds of diabetes by 0.04%. Increasing the price of food away from home by $1 would decrease the chance for diabetes by the same amount. Similar to the previous models, increasing income by $1,000 decreases the likelihood of diabetes by 0.1%, while a $1 increase in the overtime wage would decrease the risk of diabetes by 0.01%.

## DISCUSSION, CONCLUSIONS, AND LIMITATIONS

This study shows that economic factors impact risk factors and health conditions. Furthermore, the results show that it is important to differ between multiple types of food prices, such as by location of purchase. Increasing price of food away from home will decrease, while raising the food at home price will significantly increase the likelihood of risk factors and diabetes. The latter finding suggests that consumers may substitute the higher-priced food at home with food away from home, which is typically higher in fat, cholesterol, and lower in essential nutrients. In addition, studies show that consumers feel like they should 'splurge with calories' when they go out for dinner (Lin, Guthrie, and Frazão, 1999). The opposite is true for increasing the prices of food away from home: it may lead consumers to purchase food at home, which typically tends to be higher in essential nutrients and of smaller portion size. This finding is consistent with Lakdawalla, Philipson, and Bhattacharya (2005), who suggest that increasing food at home prices may lead to nutrient deficiencies. This result may reflect the difference in food quality of food at home vs. away from home. Given that restaurants do not post ingredients of menu items, controlling the intake of specific nutrients, such as fat or cholesterol, is more difficult when consuming food away from home.

Increasing the overtime wage would decrease the likelihood of risk factors and circulatory diseases. However, it could be expected that higher wages increase the marginal cost of exercise. This means that with an increasing overtime wage, consumer health increases, which is not consistent with the expectations. A positive sign would be expected, because higher opportunity cost for exercise increases the time spent at work instead of exercising, which leads to increased weight, and thus, poor health. The opposite sign of overtime wage may be a sign of collinearity between overtime wage and income in the cross-sectional data set. If the wage

increases, it also increases income, which would allow purchasing higher-priced healthier food options.

Furthermore, the analyses show that income affects risk factors and health conditions significantly. Throughout all three models it was shown that a higher income level reduces the likelihood of risk factors in addition to reducing the likelihood of health conditions. This finding is consistent with previous studies (e.g. Lakdawalla and Philipson, 2002). Thus, the obesity problem and poor health status is also very much a problem of low-income status.

Regarding the limitations of this study, the disadvantage of the CPI data is that it exists for only 27 geographic regions for the whole U.S. This means that the geographic coverage of one CPI value is not limited to one state, but overlaps several states. The BRFSS data exists for all 51 states. Thus, a one-to-one match between the CPI and BRFSS data was not possible for all states. In the case of non-existence of a state-level CPI, the aggregate region price indices are used as a proxy for the missing data. If no area or regional CPI existed to match the geographic region appropriately, the U.S. city averages are chosen. For the regional and the U.S. city aggregates, the appropriate class sizes are used to best match the metropolitan structure and inhabitant density of a state. Overall, a total of 24 different CPI values are used and clearly, they may only serve as a rough approximation to the prices that consumers would face in real life due the low search cost of some consumers and the ability to shop in many different stores. However, the wage information varies by state. Since the BRFSS contains information on 51 states and the OES survey reports wage and salary estimates for each state, each state has an individual overtime wage rate.

In conclusion, this study delivers interesting insight into the impact of economic factors on risk factors and health conditions. Considering the social cost caused by obesity-related

health conditions, it is important to determine which public policy instruments may successfully decrease the prevalence of obesity. Given that risk factors may lead to obesity-related health consequences, decreasing the likelihood of these risk factors will aid the prevention of health conditions. Further analyses will determine the effects of changes in more detailed state-level food prices on consumer health.

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**APPENDIX: Tables**

**Table 1. Descriptions of Variables used in Logit Analyses**

| Variable | Units |
|---|---|
| High blood pressure and/or high blood cholesterol | (1=yes 0=no) |
| Coronary heart disease, stroke, heart attack | (1=yes 0=no) |
| Diabetes | (1=yes 0=no) |
| African-American | (1=yes 0=no) |
| Hispanic | (1=yes 0=no) |
| Asian | (1=yes 0=no) |
| Other ethnicity | (1=yes, if Native Hawaiian, other Pacific Islander, American Indian, Alaskan Native, Multiracial, or from any other race, but not Hispanic, 0=no) |
| Male | (1=male, 0=female) |
| High school graduate | (1=yes, if x=12 years, 0=no) |
| Some college | (1 =yes, if 13≤x<16 years, 0=no) |
| College graduate | (1=yes, 0=no) |
| Married | (1= yes, if married or a member of an unmarried couple, 0=no) |
| Divorced | (1=yes, if divorced or separated, 0=no) |
| Age | Years |
| Household income | in $1,000s/household member<br>4.999.5 if x<$10,000<br>12.499.5 if x<$15,0000<br>17.499.5 if x<$20,000<br>22.499.5 if x< $25,000<br>29.999.5 if x<$35,000<br>42.499.5 if x<$50,000<br>62.499.5 if x< $75,000<br>87.500.5 if x≥$75,000 |
| Food at home price | $\left(\frac{\text{CPI of all items less foods and energy}}{\text{CPI of food at home}}\right)*100$ |
| Food away from home price | $\left(\frac{\text{CPI of all items less foods and energy}}{\text{CPI of food away from home}}\right)*100$ |
| Overtime wage | Dollars, nominal average wage of respondent's state of resident*1.5 |

**Table 1. Continued**

| Variable | Units |
|---|---|
| Moderate physical exercise | (1 =yes, if performed moderate exercise (brisk walking, bicycling, vacuuming, gardening) for at least 10 minute at a time in the past 30 days; 0=no) |
| Vigorous physical exercise | (1= yes, if performed vigorous exercise (running, aerobics, heavy yard work) for at least 10 minute at a time in the past 30 days; 0=no) |
| Smoking | (1=yes, 0=no) |
| Employed | (1= yes, 0=no) |
| South | (1=yes, 0=no) |
| Midwest | (1=yes, 0=no) |
| West | (1=yes, 0=no) |

**Table 2. Descriptive Statistics of Variables used in Logit Analyses**

| Model | Risk factor | | Health condition | | | |
|---|---|---|---|---|---|---|
| | High blood pressure/ High cholesterol level | | Coronary heart disease, stroke, heart attack | | Diabetes | |
| Variables | Mean | St.Deviation | Mean | St. Deviation | Mean | St. Deviation |
| High blood pressure/ high cholesterol level | 0.282 | 0.450 | - | - | - | - |
| Coronary heart disease, stroke, heart attack | - | - | 0.085 | 0.279 | - | - |
| Diabetes | - | - | - | - | 0.078 | 0.268 |
| African-American | 0.074 | 0.261 | 0.116 | 0.320 | 0.074 | 0.262 |
| Hispanic | 0.054 | 0.227 | 0.032 | 0.175 | 0.055 | 0.227 |
| Asian | 0.017 | 0.128 | 0.021 | 0.145 | 0.017 | 0.127 |
| Other ethnicity | 0.042 | 0.199 | 0.045 | 0.207 | 0.042 | 0.200 |
| Male | 0.422 | 0.494 | 0.408 | 0.491 | 0.417 | 0.493 |
| High school graduate | 0.299 | 0.458 | 0.304 | 0.460 | 0.299 | 0.458 |
| Some college | 0.278 | 0.448 | 0.268 | 0.443 | 0.279 | 0.448 |
| College graduate | 0.331 | 0.470 | 0.326 | 0.469 | 0.331 | 0.470 |
| Married | 0.584 | 0.493 | 0.578 | 0.494 | 0.584 | 0.493 |
| Divorced | 0.171 | 0.377 | 0.173 | 0.378 | 0.171 | 0.377 |
| Age | 48.580 | 16.567 | 48.193 | 16.273 | 48.504 | 16.580 |
| Household income | 26.815 | 17.358 | 26.723 | 17.704 | 26.786 | 17.346 |
| Food away from home price | 103.079 | 2.366 | 102.617 | 2.439 | 103.075 | 2.366 |
| Food at home price | 100.973 | 2.117 | 101.352 | 2.033 | 100.973 | 2.118 |
| Overtime wage | 25.518 | 3.313 | 25.105 | 3.751 | 25.522 | 3.314 |
| Moderate physical exercise | 0.312 | 0.464 | 0.318 | 0.466 | 0.313 | 0.464 |
| Vigorous physical exercise | 0.411 | 0.492 | 0.393 | 0.488 | 0.411 | 0.492 |
| Smoking | 0.496 | 0.500 | 0.496 | 0.500 | 0.495 | 0.500 |
| Employed | 0.625 | 0.484 | 0.626 | 0.484 | 0.624 | 0.484 |
| South | 0.311 | 0.463 | 0.479 | 0.500 | 0.311 | 0.463 |
| Midwest | 0.217 | 0.412 | 0.178 | 0.383 | 0.217 | 0.412 |
| West | 0.247 | 0.431 | 0.171 | 0.377 | 0.247 | 0.432 |
| Sample size | 198,882 | | 83,252 | | 201,836 | |

**Table 3. Results of Logit Analyses**

| Dependent Variable | Risk factor | | Health condition | | | |
|---|---|---|---|---|---|---|
| | High blood pressure/ High cholesterol level | | Coronary heart disease, stroke, heart attack | | Diabetes | |
| Variables | Estimate | St.Error | Estimate | St. Error | Estimate | St. Error |
| Intercept | -2.953*** | 0.439 | -3.604*** | 1.154 | -3.769*** | 0.691 |
| African-American | 0.620*** | 0.021 | -0.134*** | 0.047 | 0.699*** | 0.030 |
| Hispanic | -0.167*** | 0.028 | -0.061 | 0.092 | 0.285*** | 0.040 |
| Asian | -0.157*** | 0.050 | -0.511*** | 0.143 | 0.120 | 0.079 |
| Other ethnicity | 0.173*** | 0.028 | 0.304*** | 0.064 | 0.424*** | 0.040 |
| Male | 0.235*** | 0.012 | 0.540*** | 0.029 | 0.282*** | 0.018 |
| High school graduate | -0.066*** | 0.020 | -0.117*** | 0.039 | -0.119*** | 0.027 |
| Some college | -0.089*** | 0.021 | -0.076* | 0.043 | -0.082*** | 0.029 |
| College graduate | -0.292*** | 0.022 | -0.248*** | 0.048 | -0.253*** | 0.032 |
| Married | -0.025* | 0.014 | 0.055 | 0.034 | 0.056*** | 0.021 |
| Divorced | 0.174*** | 0.017 | 0.329*** | 0.041 | 0.253*** | 0.026 |
| Age | 0.052*** | 0.0004 | 0.055*** | 0.001 | 0.036*** | 0.001 |
| Household income | -0.004*** | 0.0004 | -0.012*** | 0.001 | -0.012*** | 0.002 |
| Food away from home price | -0.010*** | 0.003 | 0.005 | 0.007 | -0.009* | 0.005 |
| Food at home price | 0.008*** | 0.003 | -0.014* | 0.008 | 0.008* | 0.005 |
| Overtime wage | -0.008*** | 0.022 | -0.022*** | 0.005 | -0.003 | 0.003 |
| Moderate physical exercise | -0.098*** | 0.014 | -0.237*** | 0.031 | -0.205*** | 0.020 |
| Vigorous physical exercise | -0.380*** | 0.015 | -0.566*** | 0.038 | -0.627*** | 0.024 |
| Smoking | 0.027** | 0.011 | 0.476*** | 0.029 | 0.092*** | 0.018 |
| Employed | -0.159*** | 0.013 | -0.642*** | 0.034 | -0.381*** | 0.021 |
| South | 0.088*** | 0.019 | 0.178*** | 0.048 | 0.040 | 0.029 |
| Midwest | 0.044** | 0.020 | 0.054 | 0.056 | 0.046 | 0.032 |
| West | -0.053*** | 0.018 | -0.350*** | 0.058 | -0.066* | 0.029 |
| $R^2$ | 0.231 | | 0.248 | | 0.139 | |
| Sample size | 198,882 | | 83,252 | | 201,836 | |

Significance indicated by *, **, and *** at the 90%, 95%, and 99% confidence levels.

**Table 4. Marginal Effects of Independent Variables**

| Dependent Variable | Risk factor | | Health condition | | | |
|---|---|---|---|---|---|---|
| | High blood pressure/ High cholesterol level | | Coronary heart disease, stroke, heart attack | | Diabetes | |
| Variables | Marginal effect | Standard Error | Marginal effect | Standard Error | Marginal effect | Standard Error |
| African-American | 0.111 | 0.001 | -0.006 | 0.001 | 0.034 | 0.001 |
| Hispanic | -0.030 | 0.001 | -0.003 | 0.001 | 0.014 | 0.001 |
| Asian | -0.028 | 0.0003 | -0.023 | 0.001 | 0.006 | 0.0003 |
| Other ethnicity | 0.031 | 0.0004 | 0.014 | 0.001 | 0.021 | 0.0004 |
| Male | 0.042 | 0.001 | 0.024 | 0.002 | 0.014 | 0.001 |
| High school grad. | -0.012 | 0.001 | -0.005 | 0.002 | -0.006 | 0.001 |
| Some college | -0.016 | 0.001 | -0.003 | 0.002 | -0.004 | 0.001 |
| College graduate | -0.052 | 0.001 | -0.011 | 0.002 | -0.012 | 0.001 |
| Married | -0.004 | 0.001 | 0.002 | 0.002 | 0.003 | 0.001 |
| Divorced | 0.031 | 0.001 | 0.015 | 0.001 | 0.012 | 0.001 |
| Age | 0.010 | 0.037 | 0.002 | 0.056 | 0.002 | 0.037 |
| Household income | -0.001 | 0.039 | -0.001 | 0.061 | -0.001 | 0.039 |
| Food away from home price | -0.002 | 0.005 | 0.0002 | 0.008 | -0.0004 | 0.005 |
| Food at home price | 0.001 | 0.005 | -0.001 | 0.001 | 0.0004 | 0.005 |
| Overtime wage | -0.001 | 0.007 | -0.001 | 0.013 | -0.0001 | 0.007 |
| Moderate physical exercise | -0.017 | 0.001 | -0.011 | 0.002 | -0.010 | 0.001 |
| Vigorous physical exercise | -0.068 | 0.001 | -0.025 | 0.002 | -0.031 | 0.001 |
| Smoking | 0.005 | 0.001 | 0.021 | 0.002 | 0.005 | 0.001 |
| Employed | -0.028 | 0.001 | -0.029 | 0.002 | -0.019 | 0.001 |
| South | 0.016 | 0.001 | 0.008 | 0.002 | 0.002 | 0.001 |
| Midwest | 0.008 | 0.001 | 0.002 | 0.001 | 0.002 | 0.001 |
| West | -0.010 | 0.001 | -0.016 | 0.001 | -0.003 | 0.001 |
| Likelihood Ratio | 34,900.826 | | 9,653.753 | | 12,180.044 | |

Marginal effects are evaluated at the means of the independent variables.