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An economic analysis of decisions on physical activity and energy imbalance: cross-sectional evidence from a panel of middle-aged adults

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An economic analysis of decisions on physical activity and energy imbalance: cross-sectional evidence from a panel of middle-aged adults

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ABSTRACT

Ample evidence indicates that regular physical activity has many human health benefits. Maintenance of good physical fitness enables one to meet the physical demands of work and leisure comfortably and be less prone to a number of illnesses. In addition to physical inactivity, a poor diet is another factor in energy imbalance (more calories consumed than expended). According to the Dietary Guidelines for Americans 2005, physical inactivity and poor diets are the two most important factors contributing to the increase in overweight and obesity in the United States. Overweight and obesity are major risk factors for certain chronic diseases such as diabetes, cardiovascular diseases and some forms of cancer. However, over the past forth-five years, the obesity rate of U.S. adults has almost tripled, rising from 13% to 35%.

The objective of this study is to examine women's and men's decisions to participate in demanding physical activity and attain a healthy weight. To achieve this, a productive household model of investment in health is first derived. Second, both trivariate probit and seemingly-unrelated-regression models of decisions on physical activity and BMI or obesity are developed. These outcomes are hypothesized to be related to health attitudes, prices of food, drink and health care services and products, the respondent's personal characteristics (such as education, adjusted family income, opportunity cost of time, occupation, marital status, race and ethnicity) and the respondent's BMI or being overweight at age 25. Third, data from the 2004 round of the National Longitudinal Survey of Youth (NLSY79) are used to fit the models.

Due to basic physiological differences in men and women, separate analyses are undertaken for men and women. Also, two physical activity equations, one for participating in moderate physical activity and the other one for participating in vigorous physical activity, are fitted. Findings include: an individual who has a higher adjusted family income has a lower current BMI or a lower likelihood of being obese; females with higher education are more likely to be obese or have higher BMI, while males with higher education are less likely to be obese or have lower BMI; older males within our cohort have higher BMI or higher likelihood of being obese; higher prices for fresh fruits and vegetables and non-alcoholic drinks increase BMI and likelihood of obesity for females but not for males; and

higher prices for processed fruits and vegetables reduce BMI and likelihood of obesity for females but not for males. In a joint test of the null hypothesis of no food and drink price effects on the possibility to be obese, the hypothesis was rejected for women but not for men. When exercise is measured in minutes and weight as BMI, the hypothesis of no effects of the prices of food and drink on BMI is rejected for women but not for men. When individuals are classified as over-weight or not over-weight at age 25 and exercise is measure in minutes and weight is measured as BMI, the null hypothesis of no impact of food and drink prices on these outcomes is rejected for early non-overweight females, but not for males or early overweight females.

CHAPTER 1. INTRODUCTION

Ample evidence indicates that regular physical activity has many human health benefits. Maintenance of good physical fitness enables one to meet the physical demands of work and leisure comfortably. According to the Dietary Guidelines for Americans 2005, people with higher levels of physical fitness are at lower risk of developing chronic diseases. Conversely, a sedentary lifestyle increases risks for being overweight and obese and therefore many chronic diseases, including coronary artery disease, hypertension, stroke, osteoporosis, type 2 diabetes, and certain types of cancer. Overall, mortality rates from all causes of death are lower in physically active adults than in sedentary adults. Other research has shown that physically active adults tend to outlive those who are inactive on average (Paffenbarger *et al.*,1993; Sherman *et al.*,1994; Kaplan *et al.*, 1996; Kushi *et al.*, 1997; Kujala *et al.*, 1998). Khaw *et al.* (2008) demonstrated a combined effect of four healthy behaviors.[1] If an individual was physically active, had high blood plasma vitamin C levels, consumed moderate levels of alcohol and was a non-smoker when interviewed, he/she experienced a fourfold mortality rate reduction over the next 10 years, and for those still alive, they were the equivalent of 14 years younger in chronological age. Landers (1997) has shown that regular exercise improves mental health as indicated by relief of symptoms of depression and anxiety.

In related studies on physical activity, a longitudinal study by Seefeldt *et al.* (2002) found that components of physical fitness are relatively transitory, with low to modest correlations between physical activity and measures of physical fitness in childhood,

[1] These four health behaviors are current non-smoking, physically active, moderate alcohol intake (1-14 units a week) and plasma vitamin C >50 mmol/l indicating fruit and vegetable intake of at least five servings a day.

adolescence and adulthood. Gidlow *et al.* (2006) carried on a search of major databases to identify published studies that reported physical activity in relation to socio-economic status in adults. They found consistent evidence in 24 studies that adults in the top socio-economic strata had higher rates of participation in moderate or vigorous intensity physical activity. In particular, adults who have more education seem to exercise more regardless of their ethnicity and environment.

Nelson *et al.* (2006) followed a sibling cohort (where individuals shared households in childhood and adolescence) to young adulthood (when some continued sharing households and others lived apart) to examine the role of early discordant environments on adult twins' BMI [2] and health behavior. They concluded that adolescent household environments accounted for 8% to 10% of variation in sedentary lifestyle choice of these young people and 50% of variation in adolescent overweight. They also found that adolescent household effects on physical activity were substantially greater in young adulthood (accounting for 50% of variation) than adolescence.

Some papers have focused mainly on the relationship between physical activity and body weight. For example, Thakur (2006) used 1998-2000 data to analyze physical activity levels of women. He estimates a system of simultaneous recursive equations, where weight is explained by exercise levels and various socio-economic factors and exercise level is in turn explained by weight and various socio-economic factors. He concluded that regular leisure

[2] The term BMI is an abbreviation for body mass index. It is an estimate of body fat based on height and weight, which allows comparisons of weight holding height constant. BMI is measured as weight in kilograms divided by height in meters squared. According to National Heart, Lung, and Blood Institute, National Institutes of Health (1998) and the World Health Organization (2000), a BMI value of between 20 and 22 (kg/m^2) is "ideal" for adults regardless of gender in the sense that mortality and morbidity risks are minimized in this range. Persons with $BMI \geq 25$ (kg/m^2) are classified as overweight, and persons with $BMI \geq 30$ (kg/m^2) are classified as obese. The medical evidence shows increasingly high rates of disease and death as BMI increases above 25 (World Health Organization, 2000; Sturm, 2002).

time physical activity is negatively correlated with body weight or obesity status over time. He also showed that lack of leisure time physical exercise could explain variations in body weight of individuals, and physical exercise was most lacking in the first and third quartiles of income groups.

With regular physical activity having many human health benefits, it remains puzzling why a large fraction of the population continues to be inactive. For example, Booth and Chakravarthy (2002) reported that 28% of US adults undertake no leisure-time physical activity, and 42% of US adults undertake less than 30 minutes of physical activity each day. Thus about 70% of US adults are sedentary. Hence, a major issue is why a large segment of the adult population chooses a sedentary lifestyle. Therefore, much remains to be learned about adults' decisions to participate in physical activity and this paper will shed light on answers to these questions.

In addition to physical inactivity, a poor diet is another factor in energy imbalance (more calories consumed than expended). According to the Dietary Guidelines for Americans 2005, physical inactivity and poor diets are the two most important factors contributing to the increase in overweight and obesity in the United States. Overweight and obesity are major risk factors for certain chronic diseases such as diabetes. Results from the 2003-2004 National Health and Nutrition Examination Survey (NHANES) reveal that 66.3% of U.S. adults were overweight and 32.2% were obese; these rates are 10 percentage points higher than in 1988-1994. The Dietary Guidelines for Americans suggest that many Americans need to consume fewer calories and make wiser choices within and among food groups in order to reverse this trend. In a recent study, Etilé (2008) used French food expenditures data to examine the effects of food prices in 23 product categories on individuals' BMI distribution for a sample of French adults. He assumed quantile independence between physical activity level and income, and identified the price effects at conditional quantiles of the BMI distribution. From the quantile regressions, he found that the food price elasticity of BMI was negative and almost always significant for cereals, breaded proteins and animal and vegetable fats. Around the median BMI, a higher price of seafood products (in brine and processed) increased BMI. The price elasticity of BMI for meats in brine was negative, while the price elasticity of BMI around the median for snacks and ready-meals was positive. For fruits and vegetables in brine, he showed that a higher price increased BMI, but for processed fruits and vegetables, a higher price reduced BMI.

Auld and Powell (2008) used repeated cross-sections of adolescents (73,041 observations in total) drawn from the Monitoring the Future Survey to investigate the determinants of BMI. They showed that if the price of obtaining a calorie from dense food is lower than that of less dense food, then decreases in the relative price of energy dense foods increase adolescent body weight. The results suggest that the price of high density food (fast food meals) is negatively related to body weight, whereas the price of low density food (fruits and vegetables) is positively associated. However, the proximity of an adolescents' home to restaurants did not help explain his/her BMI, whereas a closer proximity to higher super markets density lowered body weight and probability of overweight for both male and female adolescents.

The objective of this study is to examine women's and men's decisions to participate in demanding physical activity and attain a healthy weight. Given that earlier studies have shown that light physical activity has little impact on an individuals' later health status, the focus is on decisions to participate in moderate and vigorous intensity physical activity.[3] To examine the energy balance, the focus is on the individual's current BMI and obesity status—a BMI of 30 or larger. An adult's decisions on physical activity and health status (BMI or being obese) are modeled in a productivity household framework. The determinants of these outcomes are an individual's education, opportunity cost of time, age, gender, and early health status and the prices of food and drinks and health care that he/she face in local markets. Due to important gender-related physiological differences, the empirical analysis is undertaken on men and women separately. The primary data set for the study is 2004 round of National Longitudinal Survey of the Youth 1979 Cohort (NLSY79) with geographic codes. This round is the first for the NLSY79 where individuals were asked questions about both the frequency and duration of different types of physical activity, which is critical information for this study. Seven food and drink groups and one health care category are defined; relative prices for each are expressed in real terms and are constructed from secondary local data from the American Chamber of Commerce Researchers Association (ACCRA) Cost of Living Index (CLI) 2004 report. These real prices are then merged into the 2004 round of the NLSY79 data using geo-code information.

Chapter 2 hereafter sets up the theoretical frame work. Chapter 3 describes the data in detail and Chapter 4 presents three econometric models. The main results from each econometric model are reported in Chapter 5. Chapter 6 presents conclusions.

[3] Lee and Paffenbarger (2000) concluded that light activities were not associated with reduced mortality rates, moderate activities appeared somewhat beneficial, and vigorous activities clearly predicted lower mortality rates.

CHAPTER 2. THEORETICAL MODEL

The theoretical model is based on the productive household models of health by Huffman (2006), Grossman (2000) and Rosenzweig and Schultz (1982). A household containing one or more adults is assumed to have a quasiconcave utility function,

$$u = U(H, X, C, LP, LO; Z)$$

where the utility *u* depends on the current health status of the household members (*H*), and consumption of food and drink (*X*), other purchased good (*C*) (excluding purchased health care products), and physically active leisure (*LP*) and other leisure (*LO*) leisure time. *Z* denotes fixed observables, such as education, gender, and race of adults and number and age of children. *H, C* and *LO* are assumed to be positive "goods," i.e., the marginal utilities are positive — $\frac{\partial U}{\partial H} > 0, \frac{\partial U}{\partial C} > 0, \frac{\partial U}{\partial LO} > 0$, and, hence, better adult health status gives higher household utility, and higher consumption of other purchased goods and more time spent in sedentary leisure also increases utility.

The household's production function for adult good health is:

$$H = H(LP, X, I; H_e, Z, \varphi),$$

where *H*( ) is a quasi-concave and *I* is a vector of purchased health inputs or health care. H_e denotes early health status, and φ denotes other unobservable factors which affects health, e.g., genetic pre-disposition for good health, e.g., normal BMI. In the health production function we expect $\frac{\partial H}{\partial LP} > 0, \frac{\partial H}{\partial H_e} > 0, \frac{\partial H}{\partial I} > 0$, which means holding other factors constant, more time spent on physically active leisure or larger purchased health care inputs produces better health status. We also expect that the better an individual's early health status/endowment, the better his/ her current health. However, the direct effect of *LP* on utility ($\frac{\partial U}{\partial LP}$) is uncertain because some adults may obtain large negative marginal utility for vigorous physical activity and other receive positive. But, the combined direct and indirect effects of added *LP* on utility is expected to be positive—any negative direct effect being outweighed by a positive indirect effect ($\frac{\partial u}{\partial LP} = \frac{\partial U}{\partial H} \cdot \frac{\partial H}{\partial LP} + \frac{\partial U}{\partial LP} > 0$), unless there is a corner solution. Likewise, the sign of $\frac{\partial H}{\partial X}$ is uncertain, because added consumption of whole grain foods and low fat milk will have a positive marginal product in the production of good health, but added consumption of unhealthy foods (e.g., fried foods and drinks with large amount of added sugar) may have a negative marginal product. But, the overall effect of *X* on utility is expected to be positive, $\frac{\partial u}{\partial X} = \frac{\partial U}{\partial H} \cdot \frac{\partial H}{\partial X} + \frac{\partial U}{\partial X} > 0$, because any negative indirect effect is expected to be outweighed by the positive direct effect. It is impossible on a long term basis to live without consuming food and drink.

Let P_X, P_I, P_C denote the price vectors corresponding to *X*, *I* and *C*, *W* denotes the unit wage of the individual, *T* denotes the time endowment, *V* denotes household non-labor income, and *R* denotes time spent on wage work. Then the household's utility maximization problem is stated as:

$$\begin{aligned} \max_{LP,LO,R,X,I,C} \quad & u = U(H(LP, X, I; H_e, Z, \varphi),\ X, C,\ LP, LO; Z) \\ s.t. \quad & P_X \cdot X + P_I \cdot I + P_C \cdot C = WR + V \\ & R + LP + LO = T \end{aligned} \tag{1}$$

where the first constraint is the household's cash income constraint and the second constraint is the household's time constraint. The Lagrangian for the constrained utility maximization is:

$$\begin{aligned}\Phi = & \; U(H(LP, X, I; H_e, Z, \varphi), X, C, LP, LO; Z) \\ & + \lambda(WR + V - P_X \cdot X - P_I \cdot I - P_C \cdot C) + \mu(T - R - LP - LO)\end{aligned} \quad (2)$$

where λ and μ are the Lagrange multipliers, indicating the marginal utility of cash income ($WR+V$) and marginal utility of the time endowment (T).

The first-order conditions for an optimum are:

$$\begin{array}{llll} LP: & U_H \cdot H_{LP} + U_{LP} - \mu^* \leq 0 & LP^* \cdot (U_H \cdot H_{LP} + U_{LP} - \mu^*) = 0 & LP^* \geq 0 \\ R: & \lambda^* \cdot W - \mu^* \leq 0 & R^* \cdot (\lambda^* \cdot W - \mu^*) = 0 & R^* \geq 0 \\ LO: & U_{LO} = \mu^* & & \\ X: & U_H \cdot H_X + U_X = \lambda^* P_X & & \\ I: & U_H \cdot H_I = \lambda^* P_I & & \\ C: & U_C = \lambda^* P_C & & \\ \lambda: & P_X \cdot X^* + P_I \cdot I^* + P_C \cdot C^* = WR^* + V & & \\ \mu: & R^* + LP^* + LO^* = T & & \end{array}$$

where, $U_H = \frac{\partial U}{\partial H}, U_{LP} = \frac{\partial U}{\partial LP}, U_C = \frac{\partial U}{\partial C}, U_{LO} = \frac{\partial U}{\partial LO}, U_X = \frac{\partial U}{\partial X}, H_{LP} = \frac{\partial H}{\partial LP},$ $H_X = \frac{\partial H}{\partial X}, H_I = \frac{\partial H}{\partial I}$

These first-order conditions can be solved jointly to obtain the households optimal choices for *LP, X, I, C* and *LO*. In particular, when the adults working in the labor market (i.e. $R^*>0$), the household's demand equation for *LP* is:

$$LP^* = LP(W, V, H_e, P_X, P_I, P_C, Z, \phi) \quad (3)$$

And the household's health supply function for a good health is:

$$H^* = H(LP^*, X^*, I^*; H_e, Z, \varphi) = H^*(W, V, H_e, P_X, P_I, P_C, Z, \varphi) \quad (4)$$

If the individuals are not working in the labor market (i.e. $R^* = 0$), then the wage W will not enter the optimal solution. Assuming an interior solution for LP^*, the household's demand equation for LP is:

$$LP^* = LP(V, H_e, P_X, P_I, P_C, Z, \varphi) \tag{5}$$

and the household's health supply function for adults is:

$$H^* = H(LP^*, X^*, I^*; H_e, Z, \varphi) = H^*(V, H_e, P_X, P_I, P_C, Z, \varphi) \tag{6}$$

This paper focuses on the case when the individuals are working in the labor market, so the equations (3) and (4) remain the most interest. The wage W is the opportunity cost of LP and LO, and an increase in the wage has complex substitution effects in health production and in consumption and income effects. Therefore, the expected effect of increasing W on LP and H is uncertain. If physically active leisure is a normal good, then the expected effect of larger V is to increase the demand for LP and the supply of health H.

The effects of the price P_X and P_I on LP and H are uncertain given the complex substitution effects in health production and consumption. The effects of early health status H_e on the demand for LP and H are uncertain, too. A person who has a good health status at an early age can reduce the discontinuity of LP later in life. This could be an important factor to increase the demand for LP, and further improve current health status H. Alternatively, if H_e has a long-term permanent effect on good health, the individual may need less physically active leisure in later life to achieve the same level of good health status. Therefore, he/she might exercise less in later life. Similar logic applies to a person who was in a poor health status at his/her early age.

CHAPTER 3. DATA

The primary data sources for the empirical analysis comes from the individual-level national data for the U.S. adults from the National Longitudinal Survey of the Youth, 1979 Cohort (NLSY79), 2004 round, merged with external price data obtained from the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index.

The basic empirical model in this study is:

$$\begin{aligned} Y_{ki} = {} & \beta_{k,0} + \beta_{k,1}RNI_i + \beta_{k,2}EDU_i + \beta_{k,3}V_i + \beta_{k,4}\ln(WAGE_i) + \beta_{k,5}BMI25_i + \beta_{k,6}PMF_i + \beta_{k,7}PDAIRY_i \\ & + \beta_{k,8}PFFV_i + \beta_{k,9}PPFV_i + \beta_{k,10}PALC_i + \beta_{k,11}PNALC_i + \beta_{k,12}PFF_i + \beta_{k,13}PHC_i + \beta_{k,14}MVOCCU_i \\ & + \beta_{k,15}NOCCU_i + \beta_{k,16}AGE_i + \beta_{k,17}K5_i + \beta_{k,18}K12_{ii} + \beta_{k,19}K18_i + \beta_{k,20}MARRIED_i \\ & + \beta_{k,21}BLACK_i + \beta_{k,22}HISPANIC_i + \beta_{k,23}URBAN_i + \beta_{k,24}NE_i + \beta_{k,25}NC_i + \beta_{k,26}SOUTH_i + \varepsilon_{ki} \end{aligned} \quad (7)(8)(9)$$

where k=1,2,3. Y_1 and Y_2 represent indicators for vigorous and moderate physical activities, respectively, and Y_3 is an indicator for health status, BMI or obesity status. The explanatory variables are the same in all three equations. And they are briefly defined in Table 3-1.

Table 3-1: **Variables Definition**

Variable	Definitions
Dependent Variables:	
LP1	=1 if the individual participates in vigorous physical activities regularly; =0 otherwise.
LP2	=1 if the individual participates in moderate physical activities regularly; =0 otherwise.
OBESE	=1 if the individual is currently obese(BMIC$\geq$30); =0 o.w.
LPT1	Total time the individual spends on vigorous physical activities each week (in minutes).
LPT2	Total time the individual spends on moderate physical activities each week (in minutes).
BMIC	Current Body Mass Index
Explanatory Variables	
RNI	=1 if the individual often reads nutritional information when shopping for food; =0 otherwise.
EDU[4]	Highest grade completed by the individual

[4] EDU=0 if the individual has completed less than one year of schooling; =1 if the highest grade completed is 1st grade, …=12 if the highest grade completed is 12th grade; =13 if the highest grade completed is the 1st year

Table 3-2: **Variables Definition (Continued)**

Variable	Definitions
Explanatory Variables	
V^5	Real adjusted family income in the last year(in 100,000 dollar, deflated by local ACCRA cost of living index)
V SQ	Square of V
ln(*WAGE*)	Log of real hourly rate of pay (in cents, deflated by local ACCRA cost of living index)
BMI25	Body Mass Index at age 25
BMI25SQ	Square of BMI25
PMF	Relative price of meat and fish
PDAIRY	Relative price of dairy food
PFFV	Relative price of fresh fruits and vegetables
PPFV	Relative price of processed fruits and vegetables
PALC	Relative price of alcoholic drinks
PNALC	Relative price of nonalcoholic drinks
PFF	Relative price of fast food
PHC	Relative price of health care
MVOCCU	=1 if the individual is employed in an occupation rated as requiring moderate or vigorous physical activity; and =0 if occupation is rated as requiring light or very light physical activity
NOCCU	=1 if there is no occupational information available for this individual;=0 otherwise
AGE	Age of the individual
K5	Number of children in the household with ages under 6 years old
K12	Number of children in the household with ages between 6 and 12
K18	Number of children in the household with ages between 13 and 18
MARRIED	=1 if the individual is married and spouse present; =0 otherwise.
BLACK	=1 if the individual is black; =0 otherwise.
HISPANIC	=1 if the individual is Hispanic; =0 otherwise.
URBAN	=1 if the individual lives in urban area; =0 otherwise.
NE	=1 if the individual lives in northeast; =0 otherwise.
NC	=1 if the individual lives in north central; =0 otherwise.
SOUTH	=1 if the individual lives in south; =0 otherwise.
WEST	=1 if the individual lives in west; =0 otherwise.
FATHER'S EDU	Highest grade completed by the individual's father
MOTHER'S EDU	Highest grade completed by the individual's mother
NO_FEDU	=1 if the individual does not report his/her father's education level; =0 otherwise
NO_MEDU	=1 if the individual does not report his/her mother's education level; =0 otherwise
ε	A random disturbance term with zero mean and constant variance

college, …=19 if the highest grade completed is the 7th year college, =20 if the highest grade completed is the 8th year college or more.

[5] Adjusted family income in the last year is calculated as the total net family income in the last year subtracted by the individual's earnings in the last year.

3.1 NLSY79, 2004 Round

The NLSY79 is a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. These individuals were 39-47 years old when they were interviewed in 2004, and had been personally interviewed for more than two decades. The survey was conducted annually from 1979 to 1994 and has been conducted biennially since 1996.

In 1979, the following three subsamples comprised the NLSY79 sample:(1) a cross-sectional sample of 6,111 respondents designed to be representative of the non-institutionalized civilian segment of young people living in the United States in 1979 and born between January 1, 1957, and December 31, 1964 (ages 14–21 as of December 31, 1978); (2) a supplemental sample of 5,295 respondents designed to oversample civilian Hispanic, black, and economically disadvantaged non-black/non-Hispanic youth living in the United States during 1979 and born between January 1, 1957, and December 31, 1964; (3) a sample of 1,280 respondents designed to represent the population born between January 1,1957, and December 31, 1961 (ages 17–21 as of December 31, 1978), and who were enlisted in one of the four branches of the military as of September 30, 1978.

Following the 1984 interview, 1,079 members of the military subsample were no longer eligible for interview; 201 respondents randomly selected from the entire military subsample remained in the survey. Following the 1990 interview, none of the 1,643 members of the economically disadvantaged, non-black/non-Hispanic subsample were eligible for interview.

The 2004 round of the NLSY79 contains detailed information about participation in physical activity. It does not include the economically disadvantaged non-black/non-Hispanic sub-sample, but the Hispanics and blacks are oversampled.

3.2 Sample Size

There are a total of 7,650 individuals in the 2004 round of the NLSY79. Their ages were between 39 and 47 years, hence, they were treated as a group which has been affected by similar food and drink consumption tastes and exercise tastes. Seven of them refused to answer the physical activity frequency or duration questions, and 75 of them gave "don't know" as the answer to these questions. One-hundred fifty-one of them claimed to be unable to undertake vigorous physical activity, and 133 (or 88%) of these 151 individuals reported that they had health limitations. Seventy-eight of them claimed to be unable to do moderate physical activity, and 62 (or 79%) of these 78 individuals reported that they had health limitations. Among those individuals who did answer their physical activity frequency or duration questions, some of them only answered the frequency questions while some of them just answered the duration questions, and some of them only responded to vigorous physical activity questions while some of them only responded to moderate physical activity questions. Adding them together, there are totally 461 individuals without complete physical activity information, including 224 females and 237 males; hence, they are dropped from the sample.

There were 230 individuals who did not provide their address or location, plus 9 females and 21 males who resided where no price information was available in ACCRA Cost of Living Index. Thus, they were excluded from the sample. In addition, 251 females and 111 males were currently not working in the labor market, while 10 females and 6 males did not provide their occupational information although they were working in the labor market. Besides, 667 females and 323 males did not report their working status. Hence, there was no occupation information available for 928 females and 440 males; and these 1368 individuals were excluded from the working with occupational information samples.

To make the analysis representative, 201 individuals who remained from the military sub-sample and 4 females who were pregnant were excluded. After deleting observations with missing data on other relevant variables, a total sample of 5,072 individuals remained, consisting of 2,750 women and 2,322 men.[6]

3.3 Physical Activity Measures

Two kinds of physical activity are studied in this paper, moderate intensity physical activity and vigorous intensity physical activity. Exercise at low intensity or intensive activity for short duration have been shown to have little effect on the production of good health.[7] According to Ainsworth (2003), moderate intensity activities are those that increase the human body's metabolic rate while undertaking an activity by 3 to 6 fold (3-6 METs[8]) relative to the metabolic rate while quietly resting. This increased effort is reflected in an increase in an individual's heart rate and breathing depth and frequency, but human effort is not to levels that restrict conversation during the physical activity event. Moderate intensity leisure time activities include walking, gardening, low speed bicycling, etc. Vigorous

[6] The sample size for working with occupational information sample is 4,153, including 2,112 working females and 2,041 working males.
[7] Refer to the Dietary Guidelines for Americans 2005 and Lee and Paffenbarger (2000).
[8] The term MET is an abbreviation for metabolic equivalent and is used to reflect the intensity of the specific activities. An MET is defined as the ratio of the associated metabolic rate for a specific activity divided by the resting metabolic rate. The resting metabolic rate is approximately 1 MET and reflects the energy cost of sitting quietly. Multiples of 1 MET indicates a higher energy cost for a specific activity. For example, a 2 MET activity requires twice the energy cost of sitting quietly.

intensity activities are those that increase the body's metabolic rate in excess of 6 fold (>6 METs) and are characterized by a near maximal increase in one's heart rate and breathing depth and frequency. Except for the highly trained individuals, it is generally difficult to carry on a conversation while engaging in vigorous intensity activities. Vigorous intensity leisure time activities include jogging, running, climbing, race walking, tennis, soccer, moderate to high speed bicycling, etc. Table A1 and Table A2 in APPENDIX I provide some examples of particular activities and their relevant METs.

One complication of physical activity data is that it refers to moderate or vigorous physical activity across all use of an individual's time uses. This could occur, as modeled in this paper, as part of leisure time; it could also occur during work time. For example, individuals who work in blue-collar jobs, such as construction, agriculture, and mining, regularly engage in moderate or vigorous physical activity as part of their job. Hence, the need for them to undertake physically active leisure to improve their health is reduced. To solve this problem, an occupation variable *MVOCCU* is included in the model, where *MVOCCU*=1 if an individual worked in an occupation that is rated as requiring moderate physical activity, such as carpentry and cleaning work, or a vigorous physical activity, such as coal mining and road construction; *MVOCCU*=0 if an individual worked in an occupation rated as requiring very light or light physical activity, such as printing and typing. [9]

[9] Detailed occupation category refers to APPENDIX III: Physical Activity Diary Coding Guide for Occupations.

3.4 BMI, Obesity and Overweight Measures

The NLSY79 recorded the self-reported weight of respondents in 1981, 1982, 1985, 1986, 1988, 1989, 1990, 1992, 1993, 1994, 1996, 1998, 2000, 2002 and 2004. If the respondent reached his/her 25th birthday in one of these years, his/her weight in that year was taken as his/her weight at age 25. Otherwise, his/her weight for the two years closest to age 25 are averaged and this weight becomes his/her weight at age 25. Hence, age 25 is the earliest year for which we can obtain BMI information on all members in the 2004 round. This has major advantages for achievement of maximal sample size—an important factor affecting the expected quality of the empirical results.

Self-reported height was recorded in the NLSY79 in 1981, 1982, and 1985, and a respondent's height in 1985 was taken as his/her height at age 25, except for those who were already 25 in 1982. For the latter group, their height in 1982 was taken as their height at age 25. This measure of an individual's height was used to compute BMI at age 25 and current BMI (*BMIC*). According to National Heart, Lung, and Blood Institute, National Institutes of Health (1998) and the World Health Organization (2000), persons with BMI $\geq 25(\text{kg}/m^2)$ are classified as overweight, and persons with BMI $\geq 30(\text{kg}/m^2)$ are classified as obese.

The heights and weights in NLSY79 are all self-reported, and they may contain measurement error (Judge *et al.*1985). Cawley (2000) found that in the Third National Health and Nutrition Examination Survey (NHANES III), underreporting of weight varied positively with actual weight; underweight women over-report their weight whereas overweight women underreport their weight. However, no clear pattern of misreporting occurred for height. Cawley reports that self-reported weight is an excellent predictor of measured weight, and in a regression context, the estimates are robust to whether measured or self-reported weight is used. Given Cawley's findings, in this paper self-reported height and weight are used to compute BMI and whether an individual is obese or overweight.

3.5 Health Attitude Measure

The Nutrition Labeling and Education Act (NLEA) passed by the U.S. Congress in 1990 amends the Federal Food, Drug, and Cosmetic Act (FDCA) to deem a food misbranded unless its label bears nutrition information that provides: (1) the serving size or other common household unit of measure customarily used; (2) the number of servings or other units per container; (3) the number of calories per serving and derived from total fat; (4) the amount of total fat, saturated fat, cholesterol, sodium, total carbohydrates, complex carbohydrates, sugars, total protein, and dietary fiber per serving or other unit; and (5) subject to conditions, vitamins, minerals or other nutrients.

This law requires packaged foods to display nutrition information prominently in a new label format, namely the Nutrition Facts panel. It was intended to improve consumer welfare by providing nutrition information that would assist consumers in making healthy food choices. Zarkin *et al.* (1993) investigated the potential health benefits associated with changes in food consumption since the implementation of NLEA, and concluded that relatively small changes in nutrient intake may generate large public health benefits, such as gain in life expectancy and decrease in number of cases of coronary heart disease and three types of cancer. They also note that not all consumers are likely to respond to the nutrition label changes. Mandal (2008) investigated the effect of food label information—nutrition and ingredients information—for individuals who are trying to lose weight. He found a higher usage of food labels by those who were trying to lose weight, irrespective of their current BMI. There is also greater likelihood of weight loss in the label user group.

The NLSY79 data set contains information of a respondents' use of food labels when they purchase new food items. The indicator for use of food labels is denoted as *RNI*, if the respondent always or often reads the nutritional information about calories, fat and cholesterol listed on the label when buying a food item for the first time, *RNI* =1; and if sometimes, rarely or never reads the nutritional information, *RNI* =0.

3.6 Empirical Measures of Prices of Food and Drink

The American Chamber of Commerce Researchers Association (ACCRA) collects data on prices of 63 different items in 300 U.S. cities quarterly. These data provide useful information on prices of individual food items and can also be used to construct local cost of living indexes. The ACCRA data are collected at the establishment level for a market basket of goods reflecting a mid-management household's standard of living. However, the weight for each item is derived from expenditure shares in the U.S. Bureau of Labor Statistics' 2002 Consumer Expenditure Survey. Hence, the ACCRA price data provide useful information on local prices of individual food items and health care and expenditure weights. This methodology has been successfully applied by Chou *et al.* (2004) , Powell *et al.* (2006), Auld and Powell (2008) for the price of fast food, Keng and Huffman (2007) for the price of alcohol, and Auld and Powell (2008) for the price of fruits and vegetables.

The following price variables are defined and then created: price of meat and fish *(PMF)*, price of dairy foods *(PDAIRY)*, price of fresh fruits and vegetables (*PFFV*), price of processed fruits and vegetables (*PPFV*), price of alcoholic drinks (*PALC*), price of non-alcoholic drinks (*PNALC*), price of fast food (*PFF*), and price of health care (*PHC*).

The seven food price variables were based on the food prices available in the ACCRA data set for 2004. *PMF* was derived from prices for T-bone steak, ground beef or hamburger, sausage, frying chicken, and chunk light tuna. *PDAIRY* was derived from the prices for the whole milk, eggs, margarine, and grated parmesan cheese. *PFFV* was derived from prices of bananas, potatoes, and iceberg lettuce. *PPFV* was derived from prices of frozen corn, fresh orange juice, canned peaches, canned tomatoes, and canned sweet peas. *PALC* is derived from prices for beer, wine, and liquor. *PNALC* was derived from prices for vacuum-packed coffee, and Coca Cola. *PFF* was derived from prices for a McDonald's Quarter-Pounder with cheese, an 11"-12" thin crust cheese pizza at Pizza Hut or Pizza Inn, and fried chicken (thigh and drumstick) at Kentucky Fried Chicken or Church's Fried Chicken. And *PHC* was derived for the prices from optometrist visit, doctor visit, dentist visit, and price for ibuprofen. See APPENDIX IV for more details on the list and pricing units of items included in each component.

To eliminate the locational noises of the price data and to solve the problem of different units among purchased items, a real price for each food item was created by dividing an item's price in a particular location by this item's average price among all the participating locations; and this real price was used to generate weighted consumer prices for each commodity group. Let P_{ki} denote the price of consumption category k in city i, P_{kji} denote the price of consumption item j in category k in city i, and $avgP_{ki}$ denote the average price of consumption item j in category k in city i across all participating cities in ACCRA.

Let W_{kj} denote the expenditure weight of consumption item j in category k in city i, where $\sum_j W_{kj} = 1$ for any k. Then the relative price of consumption category k in city i is:

$$P_{ki} = (P_{k1i} / avgP_{k1})\ W_{k1} + (P_{k2i} / avgP_{k2})\ W_{k2} + \ \ldots\ldots + (P_{kJ} / avgP_{kJ})\ W_{kJ} \qquad (10)$$

where J is the total number of items belonging to consumption category k. See APPENDIX IV for an example showing how the weighted price for a food group in a particular city is derived.

Not all respondents lived in an ACCRA CLI participating cities, so a different strategy was developed for obtaining prices for respondents who outside the participating cities. The price index was calculated for all ACCRA CLI participating cities in the same state as the respondent's residence, and then a simple average price was created across them. This average price for each commodity group was then used for the price respondents faced in all non ACCRA participating cities in that state. This methodology has been successfully applied by Keng and Huffman (2007) for the price of alcohol.

3.7 Demographic and Other Measures

The demographic measures in this paper include an individual's age, sex, race, ethnicity, hourly rate of pay, real adjusted family income in the last year, highest grade completed, marital status, highest grade completed by one's father, highest grade completed by one's mother, number of children under 6 years old in one's household, number of children aged between 6 and 12 in one's household, number of children aged between 13 and 18 in one's household, a dummy variable for living in a rural or urban area, and an indicator for the geographic region of one's residence. Also, for individuals that work for pay, their wage is defined as their earnings in cents per hour divided by the local ACCRA cost of living index. The real adjusted family income is computed as total family income less the respondent's earnings (in $100,000), and then divided by the local ACCRA cost of living index where the individual resides.

3.8 Summary Statistics for the Sample

Table 3-2 presents sample means and standard deviations for the sample divided by gender and by the total sample and the working sample. In the female sample, there are 2,112 working women and 2,750 total women; in the male sample, there are 2,041 working men and 2,322 total men. Thirty-five percent of the female working sample reported participating in vigorous and moderate physical activity regularly[10]; while the values for the overall female sample were 34% and 36% respectively. Fifty-one percent of the male working sample reported participating in vigorous physical activity regularly and 42% reported participating in moderate physical activity regularly; while the values for the overall male sample were 50% and 41%.

Larger differences exist between the working and the total samples when comparing the time in minutes per week that an individual allocated to moderate and vigorous physical activity. All women report a mean of 281 minutes per week of vigorous physical activity and working women report 310 minutes per week; all women report a mean of 463 minutes of moderate physical activity and working women 451 minutes. Men report substantially more time allocated to physical activity. All men report a mean of 976 minutes of vigorous physical activity per week and working men report 1,044 minutes; all men report a mean of 920 minutes of moderate physical activity per week and working men 994 minutes. These

[10] By "regularly", it means they engaged in such activity for at least thirty minutes three or more times each week.

estimates of time allocated to physical activity are self reported and undoubtedly contain some measurement error (Beyer et al. 2007).

Table 3-3: Summary Statistics of Variables[11]

	Female[12]				Male[13]			
	Working (N=2,112)		Overall Sample (N=2,750)		Working (N=2,041)		Overall Sample (N=2,322)	
Variable	Mean	S.D	Mean	S.D.	Mean	S.D	Mean	S.D.
Dependent Variables:								
LP1	0.35	0.48	0.34	0.48	0.51	0.50	0.50	0.50
LP2	0.35	0.48	0.36	0.48	0.42	0.49	0.41	0.49
OBESE	0.32	0.47	0.33	0.47	0.31	0.46	0.31	0.46
LPT1	310	1746	281	1551	1044	6108	976	5852
LPT2	451	2481	463	2560	994	7570	920	7124
BMIC	28.16	6.59	28.34	7.02	28.52	4.86	28.58	5.12
Explanatory Variables:								
RNI	0.53	0.50	0.53	0.50	0.38	0.49	0.38	0.49
EDU	13.59	2.37	13.40	2.45	13.32	2.52	13.19	2.56
V	0.31	0.43	0.35	0.54	0.22	0.37	0.21	0.36
Ln(*WAGE*)[14]	6.94	1.15	6.92	1.15	7.34	0.89	7.33	0.90
BMI25	23.81	4.67	24.01	5.00	25.09	3.75	25.08	3.80
PMF	1.03	0.13	1.03	0.13	1.03	0.13	1.04	0.13
PDAIRY	1.02	0.13	1.03	0.13	1.02	0.13	1.03	0.13
PFFV	1.03	0.15	1.04	0.15	1.04	0.15	1.04	0.16
PPFV	1.03	0.13	1.03	0.14	1.03	0.14	1.03	0.14
PALC	1.00	0.07	1.00	0.07	0.99	0.07	1.00	0.07
PNALC	1.01	0.10	1.01	0.10	1.01	0.10	1.02	0.10
PFF	1.00	0.05	1.00	0.05	1.01	0.05	1.01	0.05
PHC	1.03	0.12	1.03	0.12	1.04	0.12	1.04	0.12
MVOCCU	0.10	0.30	0.08	0.27	0.21	0.41	0.19	0.39
NOCCU	-	-	0.23	0.42	-	-	0.12	0.33
AGE	43.12	2.26	43.12	2.27	42.96	2.22	42.96	2.21
K5	0.08	0.29	0.09	0.32	0.14	0.41	0.13	0.41
K12	0.31	0.61	0.32	0.62	0.31	0.62	0.29	0.61

[11] Here, working sample is actually the working with occupational information sample.
[12] For *LP1, LP2*, *OBESE*, the working sample size is 2,130, and the overall sample size is 2,775.
[13] For *LP1, LP2*, *OBESE*, the working sample size is 2,056, and the overall sample size is 2,341.
[14]This is the log of real actual wage, and the sample size is 2,087 for female and 2,056 for male. The summary statistics for the predicted log of real wage are 7.15 (0.28) and 7.12 (0.29) for female working and overall sample, and 7.44 (0.30) and 7.41 (0.31) for male working and overall sample, with standard deviation in the parenthesis.

Table 3-4: Summary Statistics of Variables (Continued)

Variable	Female				Male			
	Working (N=2,112)		Overall Sample (N=2,750)		Working (N=2,041)		Overall Sample (N=2,322)	
	Mean	S.D	Mean	S.D.	Mean	S.D	Mean	S.D.
Explanatory Variables:								
K18	0.66	0.81	0.65	0.83	0.50	0.80	0.48	0.79
MARRIED	0.54	0.50	0.54	0.50	0.59	0.49	0.56	0.50
BLACK	0.28	0.45	0.29	0.46	0.26	0.44	0.27	0.45
HISPANIC	0.19	0.39	0.18	0.39	0.18	0.38	0.18	0.38
URBAN	0.78	0.46	0.77	0.47	0.78	0.48	0.79	0.48
NE	0.14	0.35	0.14	0.35	0.14	0.35	0.15	0.35
NC	0.25	0.44	0.25	0.43	0.27	0.45	0.26	0.44
SOUTH	0.42	0.49	0.43	0.49	0.39	0.49	0.39	0.49
WEST	0.18	0.39	0.19	0.39	0.19	0.39	0.20	0.40
FATHER'S EDU	9.39	5.12	9.39	5.12	9.99	5.15	9.99	5.15
MOTHER'S EDU	10.33	3.82	10.33	3.82	10.51	3.98	10.51	3.98
NO_FEDU	0.14	0.34	0.14	0.34	0.12	0.32	0.12	0.32
NO_MEDU	0.05	0.21	0.05	0.21	0.05	0.22	0.05	0.22

Thirty-two percent of working females were obese, while for the total female sample the obesity rate was 1 percent higher; for males, the obesity rate was 31% for both working sample and the total sample. The average BMI for working females (and males) was slightly lower than that for the total sample. Considering the working sample, from age 25 to 2004, average BMI increased 18.27% for females and 13.67% for males, from 23.81 to 28.16 and 25.09 to 28.52 respectively. Over the same period, the standard deviation of BMI rose 41.11% for females and 29.60% for males, from 4.67 to 6.59 and 3.75 to 4.86 respectively. These statistics suggest that BMI became more dispersed and nearer to the threshold of being obese than away from the threshold over time.

It is of interest to examine the sample cross classified by moderate and vigorous physical activity in 2004. Table 3-3 shows the percentages of females and males who participated in moderate physical activity and vigorous physical activity regularly. Based on the overall sample, for women, 18.6% participated in both types of physical activities regularly; 15.9% participated in vigorous physical activity regularly but did not participate in moderate physical activity regularly; 17.3% participated in moderate physical activity regularly but did not participate in vigorous physical activity regularly; and 48.2% participated in neither type of physical activity regularly. For men, 28.9% participated in both types of physical activities regularly; 20.7% participated in vigorous physical activity regularly but did not participate in moderate physical activity regularly; 12.0% participated in moderate physical activity regularly but did not participate in vigorous physical activity regularly; and 38.4% participated in neither type of physical activity regularly. Hence, it is concluded that participation in regular moderate and vigorous physical activity is not mutually exclusive, and regular participation in moderate physical activity is not a transition from inactivity to regular participation in vigorous physical activity.

Table 3-5: Regular Participation in Moderate Physical Activity and Vigorous Physical Activity (Overall Sample)

Part A. Female Sample (N=2,775):

		Does the individual participate in moderate physical activities regularly?	
		Yes	No
Does the individual participate in vigorous physical activities regularly?	Yes	517(18.6%)	440(15.9%)
	No	480(17.3%)	1338(48.2%)

Part B. Male Sample (N=2,341):

		Does the individual participate in moderate physical activities regularly?	
		Yes	No

Does the individual participate in vigorous physical activities regularly?	Yes	677(28.9%)	484(20.7%)
	No	280(12.0%)	900(38.4%)

After checking the participation in two types of physical activity on a regular basis, it is also worthy investigating the participation on a Yes or No basis. Table 3-4 presents the results for this investigation. Considering the overall sample, 17.8% of females did not participate in either type of physical activity; while for male sample, this rate was 5.5 percent lower. About 57.2% of females spent time on both types of physical activity; while for male sample, this rate was 10 percent higher.

Table 3-6: Time Spent on Moderate Physical Activity and Vigorous Physical Activity (Overall Sample)

Part A. Female Sample (N=2,750):

		Does the individual spend some time on moderate physical activities each week?	
		Yes	No
Does the individual spend some time on vigorous physical activities each week?	Yes	1573(57.2%)	189(6.9%)
	No	497(18.1%)	491(17.8%)

Part B. Male Sample (N=2,322):

		Does the individual spend some time on moderate physical activities each week?	
		Yes	No
Does the individual spend some time on vigorous physical activities each week?	Yes	1557(67.1%)	271(11.7%)
	No	208(8.9%)	286(12.3%)

A larger share of females than males read food labels, 53% versus 38%. Working women have slightly higher average level of schooling completed than men, 13.6 years for working females and 13.3 for working males. However, the mean wage for working males was higher than for females by 27%. Average years of schooling in the overall samples are slightly lower than the working sample.

There are little differences across working and total females or males in mean prices of food and drink. Based on the working with occupational information samples, in 2004 10% of females and 21% of males worked in a moderate or vigorous occupation.

The average age of female respondents was 43.12 years in 2004, and approximately 56% of females were married and had a spouse present in the household. Around two-third (65%) had children aged between 13 and 18 and only 9% of females had children with age under 6 years old at home. About 29% of females were black and 18% were Hispanic. Most (77%) females lived in the urban area and just one-third had children aged between 6 and 12 at home.

For the male sample, the average age was 42.96 years in 2004, very similar to female sample. About 56% of males were married and had a spouse present in the household. Nearly one-third (29%) had children aged between 6 and 12 at home and 48% of males had children aged between 13 and 18, and nearly one quarter (13%) had children with age under 6 years old at home. Approximately 27% of males were black and 18% were Hispanic. Similar to the female sample, most (79%) males lived in the urban area. The average real adjusted family income of male respondents was $21,000, which is $14,000 less than female respondents'.

3.9 Predicted Wage

The NLSY computes the average hourly wage, earned at the primary job, of a respondent in each year of the survey. Then, the real wage is derived as the average hourly wage divided by the ACCRA cost of living index for the area where the respondent resides. However, to take account of measurement errors and potential endogeneity of individuals' wage, wage equations were fitted for all working respondents. The dynamic effects of past health status on wages are accounted by including an individual's BMI at age 25 (*BMI25*) and its square as regressors. This is new, although Cawley (2004) experimented with including a 7-year lagged value of BMI in wage equations for men and women in the NLSY survey.

Working for a wage is an individual's choice, and this choice is reflected in the probability that his/her participation in wage work. Hence, the participation decision must be controlled in fitting the ln(*WAGE*) equation (Heckman 1979). To account for this, the labor force participation equations are fitted to data for working and nonworking, and then the predicted participation probabilities for these equations are then used to construct a Heckman sample-selectivity variable, the predicted probability of not working—*PNWORK*—to be included as a regressor in the ln(*WAGE*) equation. Prior studies have shown that women's and men's wage equations differ significantly, and hence, they and all other equations are fitted separately for women and men.

The wage equation is then fitted by gender to those observations that reported positive hours of labor market work. Since the fitted wage equations are now fixed up for selectivity, the probability of participating in labor market can be set to one and each individual's wage whether they work for a wage or not can be predicted. This predicted wage is a proxy or indicator variable for the true opportunity cost of time of each individual (Greene 2003, p. 87-88).

To minimize the noise of the sample, this paper dropped the observations with actual wage lower than $1 or greater than $100 in the labor force participation equation and the wage equation, so the sample sizes in these equations are different from those shown in Table 3-2. Another contribution to the difference in sample size is that these two equations include different explanatory variables, such as *FATHER'S EDU* and *MOTHER'S EDU*, those variables contain missing variables for some observations in Table 3-2.

Results for the female and male labor force participation decisions are reported in Table 3-5. The probability that an individual is in the labor force declines as their adjusted real family income increases up to $291,000 for women and up to $58,000 for men thereafter increases. Probability of working increases as a female's or male's own education increases. Also, an increase in mother's education increases her daughter's and son's labor force participation probabilities. However, an increase in father's education reduces the probability of his daughter's and son's labor force participation. If father's education is missing, the probability of labor force participation for his daughters and sons is lower. However, if missing mother's education information has a positive and significant effect on her son's probability of labor force participation. For women, a larger BMI at age 25 increases the probability of her later labor force participation up to a *BMI25* of 26, and thereafter a larger *BMI25* reduces this probability. For men, a larger BMI at age 25 increases their later labor force participation, provided *BMI25* is larger than 25. However, these effects are not significantly different from zero at the 5% level. Among price effects on labor force participation, the impact of the price of fast food (PFF) is noteworthy. As the real price of fast food increases, the probability of labor force participation of women and men declines. An individual's being married increases his/her probability of labor force participation. Black males are less likely to be in the labor force. Women residing in the Northeast, North Central and South Regions are more likely to be in the labor force than women residing in the Western Region.

Table 3-7: Maximum Likelihood Estimates of the Labor Force Participation Probit Model[15]

Variable	Female Sample (N =2,133) Coeff.	Female Sample Z-Value	Male Sample (N =1,898) Coeff.	Male Sample Z-Value
FATHER'S EDU	-0.026	-1.762	-0.038	-2.027
MOTHER'S EDU	0.018	1.06	0.069	3.242
NO_FEDU	-0.219	-1.158	-0.509	-2.248
NO_MEDU	-0.073	-0.301	0.832	2.782
EDU	0.069	3.521	0.047	1.972
V	-0.599	-2.569	-0.991	-1.824
V SQ	0.103	1.538	0.844	1.618
BMI25	0.062	1.074	-0.14	-1.017
BMI25SQ	-0.001	-1.175	0.003	1.088
PMF	0.407	0.549	0.767	0.795
PDAIRY	1.82	1.823	0.414	0.352
PFFV	-0.432	-0.693	0.795	0.994
PPFV	-2.356	-2.586	-0.931	-0.891
PALC	0.223	0.282	-0.881	-0.948
PNALC	1.818	1.662	-1.048	-0.787
PFF	-2.06	-1.902	-3.489	-2.449
PHC	0.729	1.295	0.333	0.464
K5	-0.046	-0.341	-0.042	-0.318
K12	0.031	0.45	-0.004	-0.041
K18	-0.018	-0.381	0.085	1.137
MARRIED	0.32	2.723	0.247	1.693
BLACK	-0.116	-1.088	-0.28	-2.187
HISPANIC	0.02	0.157	0.021	0.122
URBAN	0.09	1.002	0.028	0.256
NE	0.645	2.552	0.005	0.016
NC	0.544	2.376	0.187	0.665
SOUTH	0.439	1.76	-0.137	-0.456
Intercept	-0.826	-0.508	6.449	2.601
Pseudo R Square	0.039		0.081	
-Log Likelihood	620.037		370.430	

[15] The dependent variable is a dichotomous variable WORK, =1 if the individual is currently working; =0 o.w.

Table 3-8: Least Square Regression Estimates of the Log Wage Equation with Selection

	Female Sample (N=2,286)		Male Sample (N =2,140)	
Variable	Coeff.	T-Value	Coeff.	T-Value
AGE	-0.002	-0.465	0.004	0.714
FATHER'S EDU	0.008	2.086	0.013	3.813
NO_FEDU	0.007	0.136	0.106	2.077
EDU	0.103	17.015	0.078	14.387
BMI25	-0.039	-2.326	0.04	1.594
BMI25SQ	0.001	2.011	-0.001	-1.802
MARRIED	0.003	0.143	0.242	9.632
BLACK	-0.124	-4.178	-0.192	-5.934
HISPANIC	0.059	1.728	-0.042	-1.168
URBAN	0.092	3.638	-0.029	-1.17
NE	0.087	2.065	0.01	0.25
NC	0.137	3.549	0.059	1.56
SOUTH	0.145	4.314	0.105	3.088
PNWORK[16]	0.236	0.718	-0.582	-1.752
Intercept	6.178	17.645	5.487	13.182
R Square	0.204		0.261	

Estimates of the ln wage equations, controlling for selection, are reported in Table 3-6. As reported in other studies, an individual's own education has a positive and significant effect on his/her wage—a 10.3% increase per year of schooling for women and 7.8% for men. These results provide new information about the impact of past/early health status—BMI at age 25 (*BMI25*) on wage rates. Results show that the impact of early BMI is not linear on the ln wage at a later date. A larger early BMI (*BMI25*) reduces the later wage of women up to a *BMI25* of 32, and thereafter, larger *BMI25* increases her wage. A larger *BMI25* for men increases their later wage up to a *BMI25* of 25, but thereafter, a larger *BMI25* reduces their wage. These findings are somewhat different from results that include current BMI in the (current) wage equation because current BMI and the current wage are likely to be

[16] This is the predicted probability of not working from the labor participation regression (refer to Table 3.4). This variable controls for selection into labor force participation.

endogenous (Cawley 2004).[17] Married men earn 24% more than non-married men. Black women earn 12% less than white women, and black men earn 19% less than white men. Women's real wage is about 9% higher in urban than rural areas. Real wage rates are lower in the West than in other regions. As the probability of not working increases for men, their real wage offer declines. There is not significant effect of the probability of not working on women's wage rates.

[17] Clearly current BMI does not cause *BMI25*, but there could be some unmeasured component that the two have in common. Including *BMI25* as a regressor in the wage equation does introduce some dynamics of past health status on later wage rates and does clean up the interpretation of the estimated coefficients of other regressors in the wage equation.

CHAPTER 4. EMPIRICAL MODEL

This chapter defines different models, and discusses the expected signs of explanatory variables for equations (7) to (9). The transition from the theoretical model to the empirical specification raises some issues. First, an interior solution for hours of work for pay and for physically active leisure was the focus of the theoretical model derived in CHAPTER 2. Corner solutions exist in the data for these variables and for household decisions on some of the food and drink choices, but there is little direct information available on the latter. The empirical results are reported for models where dependent variables are measured dichotomously, a trivariate probit model, and continuously, seemingly unrelated regression (SUR) model I and SUR model II.

In the empirical models, two measures of participation in physical activity are explored. One is the participation decision, which is coded as a qualitative outcome e.g., 1 for regular participation and 0 for regular nonparticipation. A second measure is the extent of participation—minutes of time per week reported for regular moderate and vigorous physical activity, which is a continuous measure. Likewise two types of variables are used to represent current health status, a qualitative variable coded as 1 for an individual being obese and 0 otherwise, and a continuous measure, *BMIC*. In addition, an individual's BMI at age 25 (*BMI25*) is used as an early indicator of one's health, and in some of the results, the sample is partitioned by whether they have a BMI of 25 or larger, which is associated with an individual's being over-weight or not at age 25. Individual who fall into this classification are expected to be more vulnerable to obesity at later ages.

Finally, there are no data on food and drink consumption in the NLSY79, therefore food and drink demand equations cannot be estimated, but as shown in the theoretical model, the prices of food and drink are expected to enter the demand for physical activity and for BMI.

4.1 Trivariate Probit Model

The trivariate probit model focuses on explaining an individual's physical activity participation decision and obesity status, which are qualitative outcomes. Respondents are classified as partaking in "regular" physical activity (vigorous or moderate) if they engage in such activities for at least thirty minutes three or more times per week. In the trivariate probit model, the dependent variables in equations (7) to (9) are defined as $Y_{1i} \equiv LP_{1i}$, $Y_{2i} \equiv LP_{2i}$, $Y_{3i} \equiv OBESE_i$. While the explanatory variables are the same as it shows in equations (7) to (9).

The three dependent variables are all binary indicators taking a value of one or zero. $LP_1 = 1$ if the respondent participated in vigorous intensity activity regularly, $LP_1 = 0$ otherwise. $LP_2 = 1$ if the individual participated in moderate activity regularly, $LP_2 = 0$ otherwise. [18] Respondents are classified as obese (*OBESE* = 1) if their current BMI (*BMIC*) was greater or equal to 30, *OBESE* = 0 otherwise.

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[18] According to Ainsworth (2003), moderate intensity activities are those that increase the body's resting metabolic rate by 3 to 6 fold (3-6 METs). And activity with 2 METs includes driving an automobile or light truck, activity with 1MET or less than 1 MET is categorized as inactivity, including sleeping, sitting quietly and watching TV. In the 2004 interview of NLSY79, the respondents were asked about the frequency and duration of light or moderate activities. But the light or moderate activities were defined as those activities that cause only light sweating or slight to moderate increase in breathing or heart rate. So we think that the 2004 interview actually asked the respondents questions about the moderate activity instead of light or moderate activity. Hence, all the data for light or moderate activity from 2004 interview are interpreted as data for moderate activity in this paper.

Assume that a system of latent variable LP_1^*, LP_2^*, and $OBESE^*$ exists, say due to measurement error, but only LP_1, LP_2, and $OBESE$ are observed. Denote all the independent variables as a 26×1 vector x and all the coefficients as a 26×1 vector β_k where k=1, 2, 3.[19]

$$\begin{aligned} LP_{1i}^* &= \beta_1' x_i - \varepsilon_{1i} \\ LP_{2i}^* &= \beta_2' x_i - \varepsilon_{2i} \\ OBESE_i^* &= \beta_3' x_i - \varepsilon_{3i} \end{aligned}, \quad LP_{ji} = \begin{cases} 1 & LP_{ji}^* > 0 \\ 0 & LP_{ji}^* \le 0 \end{cases} \quad j = 1,2 \ \text{ and } \ OBESE_i = \begin{cases} 1 & OBESE_i^* > 0 \\ 0 & OBESE_i^* \le 0 \end{cases}.$$

Furthermore, assume the disturbances are jointly normally distributed:

$$\begin{pmatrix} \varepsilon_{1i} \\ \varepsilon_{2i} \\ \varepsilon_{3i} \end{pmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho_{21} & \rho_{31} \\ \rho_{21} & 1 & \rho_{32} \\ \rho_{31} & \rho_{32} & 1 \end{bmatrix} \right)$$

Parameter ρ_{mj} will be positive if ε_{mi} and ε_{ji} are positively correlated and will be negative if ε_{mi} and ε_{ji} are negatively correlated, where m=*2, 3,* j =1, 2, $m > j$.

The parameters of the model can be estimated by the method of simulated maximum likelihood (SML) using the Geweke-Hajivassiliou-Keane (GHK) smooth recursive simulator. The simulated maximum likelihood technique consists in simulating the trivariate normal integrals which are involved in the likelihood equation. The GHK simulator exploits the Cholesky decomposition of the covariance matrix, so that the joint probability originally based on unobservables can be written as the product of univariate conditional probabilities, where the ε s are substituted by error terms independent from each other. The simulated probabilities are then fed into the likelihood function which is finally maximized using

[19] When considering the working sample, all the observations have occupational information available, i.e. *NOCCU*=0 for all the observations, so this variable is dropped when estimating the regression, therefore, in this case the dimension of x is 25 by 1.

traditional techniques. See Greene (2003, pp 932-933) for a description of the simulation algorithm used here.

A large difference exists in human physiology by gender so that it is important to undertake separate analyses for men and women in this study. For each female/male sample, it is fitted twice: (1) First, the number of children variables (*K5, K12* and *K18*) is included as explanatory variables; and (2) these variables are excluded. There are two reasons for this. First, because there are some observations with missing data on children, a larger sample can be obtained if the number of children by age group is excluded. In particular, over 170 additional observations are obtained for the female sample, and over 250 additional observations are obtained for the male sample. Second, children are expected to be less important for explaining men's decisions on physical activity and weight for height than for women. Mothers are more integrated into the activities of their children in a way that might affect decision on physical activity and weight for height than for fathers. However, this paper attempts to maintain some similarities in the fitted models across gender.

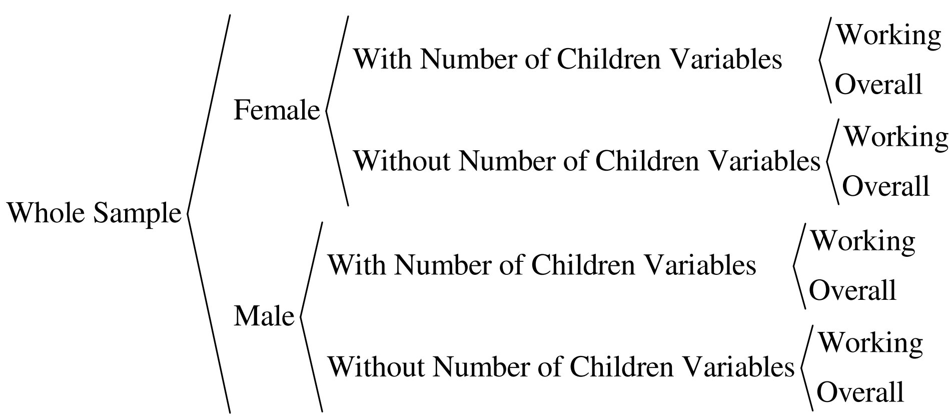
In addition, the model is fitted to the with/without occupational information sample and the working with occupational information sample. For convenience, these two samples are named the "overall sample" and "working sample" for the rest of this paper[20]. The inclusion of the occupational variable *MVOCCU* is important since there is no way to tell from the survey whether the individual reported exclusively the leisure time physical activity, or the occupational physical activity, or both. But for those who did not report working status, or were not working in the labor market, or working for wage but did not report occupations,

[20] All working individuals reported their occupation except for 10 females and 6 males, so it is reasonable to use the "working sample" to indicate the working with occupational information sample

there was no occupational information available. Consider the working sample, over 540 female observations and over 220 male observations are lost. Therefore, the model is fitted to the overall sample adding a new dummy variable *NOCCU* taking a value of 1 if the there is missing data for occupation and 0 otherwise. For those individuals without occupational information (*NOCCU* = 1), assign them to have a light physical occupation activity value, i.e. let *MVOCCU*=0, but the new dummy variable *NOCCU* will largely control for the fact that these individuals may be different than others who reported light physical activity. Then the model is fitted to the working sample so that *MVOCCU* provides accurate information.

In summary there are eight sets of results for the trivariate probit regressions. Figure 4-1 shows the details of the sub-samples used to fit the trivariate probit model.

Figure 4-1: Sub-samples for Trivariate Probit model and SUR Model I



4.2 Seemingly Unrelated Regression Model I

The two SUR models focus on explaining the amount of time allocated to physical activity participation and the individual's current BMI, which are continuous variables. Although the dichotomous variables are thought to contain less noise, the continuous variables are meant to provide more complete information. The dependent variables in equations (7) to (9) are $Y_{1i} \equiv LPT_{1i}$, $Y_{2i} \equiv LPT_{2i}$, $Y_{3i} \equiv BMIC_i$ for these two SUR models, where LPT_{1i} denotes the total time (in minutes) that the individual spends on vigorous physical activity each week, and LPT_{2i} indicates the total time (in minutes) that the individual spends on moderate physical activity each week, $BMIC_i$ represents the individual's current BMI. The independent variables are exactly the same as it shows in equations (7) to (9) for SUR model I.

Assume that $E[\varepsilon\varepsilon' | X] = \Omega$ and $E[\varepsilon | X] = O$ where $\varepsilon = [\varepsilon_1^{'}, \varepsilon_2^{'}, \varepsilon_3^{'}]'$, Ω is a 3×3 matrix representing the covariance of residuals between the equations, i.e., assume that an individual's two physical activity decisions are correlated with his/her current BMI through the unobservables. For example, an individual who is less aware or concerned about fitness will be less careful with what he/she eats and drinks, thus may have a higher BMI, and at the same time will generally be inactive.

Similar to trivariate probit model, SUR model I is fitted to 8 sub-samples. First, the model is fitted to a female sample and a male sample, where for each sample it considers two cases: including the number of children by age as explanatory variables and excluding these variables. Next, the model is fitted to the overall sample and the working sub-sample. The layout of the sampling strategy is displayed in Figure 4-1. When the model is fitted to the working female or male sample, the variable *NOCCU* is excluded as an explanatory variable.

4.3 Seemingly Unrelated Regression Model II

SUR model II is used to explain the intensity of physical activity and weight for height, but the sample of females and males is partitioned by their weight at age 25. Since all of the individuals in our sample are older than 25 years, this does not create a sample based on current conditions. Individuals who were over-weight at an early age may be more vulnerable to future cheap food and stressful environments than others. The two samples are: early overweight sub-sample (with $BMI25 \geq 25$) and early non-overweight sub-sample ($BMI25<25$). And the independent variable *BMI25* is dropped from the regressors for endogenity concern.

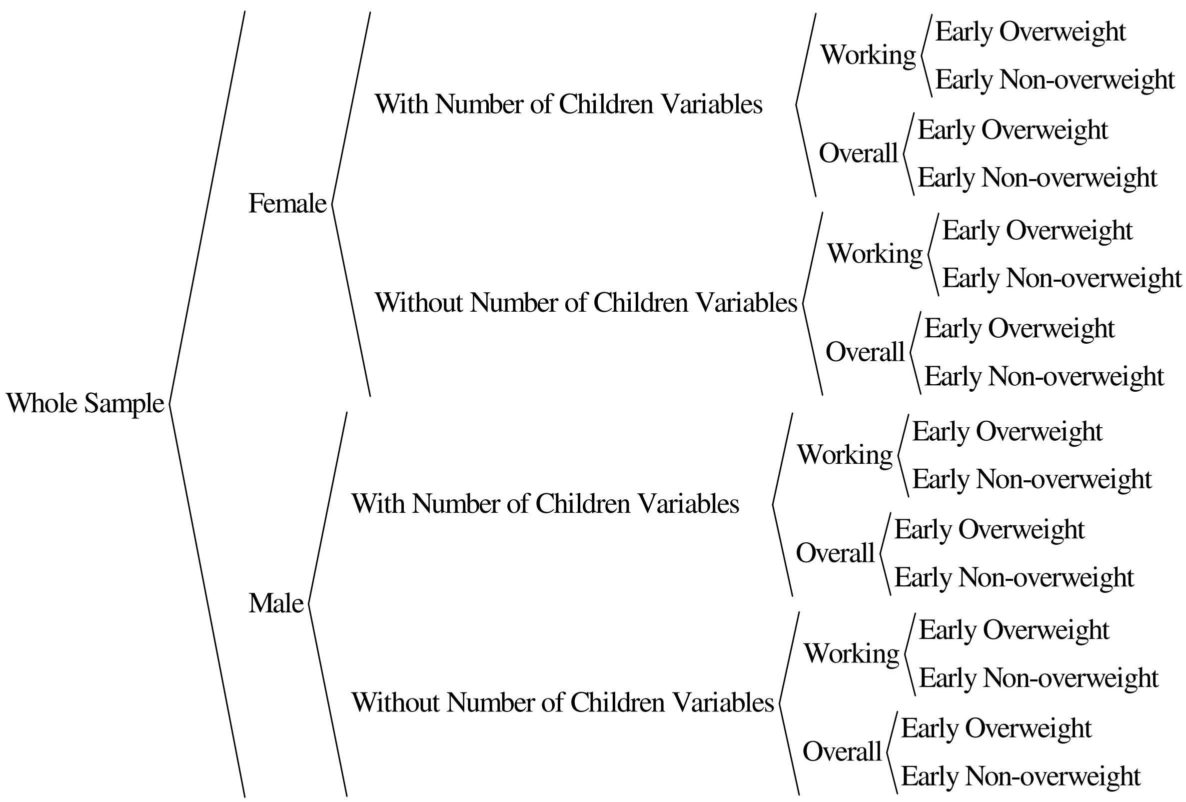
Finally SUR model II is fitted to16 sub-samples. Figure 4-2 displays the various sub-samples.

4.4 Explanatory Variables and Hypothesis

For each model, the three equations contain the same set of explanatory variables. See Table 3-1 and Table 3-2 in CHAPTER 3 for variable definitions and summary statistics. The following of this section turns to a discussion of the expected signs of coefficients in equation (7) to (9).

If the respondent always or often reads the nutritional information about calories, fat and cholesterol listed on the label when buying a food item for the first time (RNI =1), he/she is expected to be more concerned with fitness and health status. Hence, he/she is more likely to participate in physical activities and is willing to spend more time on physical activities, so that he/she is expected to have a lower probability of becoming obese and a lower BMI ($\beta_{1,1}$>0, $\beta_{2,1}$>0, $\beta_{3,1}$<0).

Figure 4-2: Sub-samples for SUR Model II



According to Schultz (1975) and Huffman (2001), education has a positive effect on decision making, so individuals with higher education are expected to have a better understanding of how physical activity enters the production of good health, and seem more likely to partake in regular vigorous and moderate physical activity, and are expected to be willing to spend more time on physical activity. They will also choose the food and drinks consumed for fitness and health concern, for example they will eat more nutritious and low calorie food while eating less high fat food. Hence, individuals with higher education are expected to have lower BMI. However, individuals at low levels of education tend to participate in moderate or vigorous occupation which requires greater amounts of physical activity, but as education rises they move into sedentary light occupation. Hence, there could be a negative impact of education, especially for male's decisions to participate in regular moderate or vigorous physical activity, or male's decisions on total time spent on moderate or vigorous physical activity. Hence the sign of $\beta_{k,2}$ is uncertain ($\beta_{k,2} >=< 0$).

Real adjusted family income (*V*) is defined as a household's total family income less the real earning of the adult being modeled then divided by the ACCRA cost of living index for the location where the individual resides. If good health is a normal good, it is expected that $\beta_{1,3} > 0$, $\beta_{2,3} > 0$ and $\beta_{3,3} < 0$. As the opportunity cost of time (ln(*WAGE*)) increases, individuals will see the time cost of consuming leisure time activities increasing. So they could be less likely to participate in vigorous or moderate physical activity, and spend less time on vigorous or moderate physical activity, hence they will have higher BMI. But when wage increases, individuals' income also increases, therefore, they might be more likely to participate in vigorous or moderate physical activity and would like to spend more time on physical activities if physically active leisure is a normal good. Thus, the sign of $\beta_{k,4}$ is uncertain ($\beta_{k,4} >=< 0$).

NLSY79 participants were 14-22 years old when first surveyed, so the individual's BMI at age 25 (*BMI25*) is chosen as measure of early weight status. An individual's *BMI25* is determined by genetics, early family investments in the health of the person, and early behavioral tendencies. It is exogenous to the individual's current behavior. Since BMI does not distinguish between bulk due to muscle or fat, males who tended to be physically active as teenagers may have larger BMI than less active males on average. However, *BMI25* might have either a positive or negative effect on decisions to participate in physical activity and decisions on the time spent on physical activity ($\beta_{1,5} >=< 0, \beta_{2,5} >=< 0$). But *BMI25* are expected to have a positive effect on current weight status ($\beta_{3,5} > 0$) for genetics reason.

Eight prices are included in the empirical models, including prices for five food categories (*PMF, PDAIRY, PFFV, PPFV, PFF*) and two drink categories (*PALC, PNALC*) and one health care category (*PHC*). The food and drink price effects on vigorous or moderate physical activity are not determined. If the item is a substitute for vigorous or moderate physical activity, the increase of the price will cause an increase of probability of partaking in vigorous or moderate physical activity and an increase of time spent on vigorous or moderate physical activity. But if the item is a complement for vigorous or moderate physical activity, then the price will have a negative effect on vigorous or moderate physical activity ($\beta_{1,6} \cdots \beta_{1,11} >=< 0$, $\beta_{2,6} \cdots \beta_{2,11} >=< 0$). When price of meat and fish (*PMF*) increases, the individual will reduce his/her consumption of meat and fish which belongs to energy dense food category, so it is hypothesized that his/her current BMI (*BMIC*) will decrease and his/her obesity status will improve ($\beta_{3,6} < 0$). Similarly, price of dairy goods (*PDARIY*), price of alcoholic drinks (*PALC*) and price of fast food (*PFF*) are also expected to affect a person's *BMIC* or obesity status negatively ($\beta_{3,7} < 0$, $\beta_{3,10} < 0$, $\beta_{3,12} < 0$). But for price of fresh fruit and vegetables (*PFFV*) and price of non-alcoholic drinks (*PNALC*), their effects on *BMIC* and obesity status are expected to be positive, because those food and drink items are less energy dense and more healthful food or drinks ($\beta_{3,8} > 0$, $\beta_{3,11} > 0$). However, the effect of price of processed fruits and vegetables (*PPFV*) on *BMIC* and obesity status is not certain, because fruits and vegetables are less energy dense food, but the added sugar or fat when processing makes them more energy dense ($\beta_{3,9}$ >=<0). Regarding the price of health care (*PHC*), when *PHC* increases, the individual would like a relatively "cheaper" way to maintain a good health status, such as participating in vigorous physical activity or moderate physical activity more regularly, and spending more time on physical activity. Hence, the demand for LP_k and LPT_k (*k*=1, 2) will increase with the rise of *PHC* ($\beta_{1,13}$ >0, $\beta_{2,13}$ >0).. But the expected effect of *PHC* on *BMIC* and obesity status cannot be easily identified. If health care is a normal good, an increase in *PHC* will decrease the demand for health care because of the income effect. Hence, *BMIC* will increase and obesity status will get worse. But the substitution of *LP* for health care will offset the negative income effect of an increase in *PHC* on *BMIC*, therefore, it is hard to tell the sign of the combined effect of *PHC* on *BMIC* or obesity status ($\beta_{3,13}$ >=<0).

If an individual works in a moderate or vigorous occupation (*MVOCCU*=1), he/she is more likely to partake in moderate or vigorous physical activity, and will spend more time on physical activity, because NLSY79 survey does not identify the occupational physical activity from leisure time physical activity ($\beta_{1,14}$ >0, $\beta_{2,14}$ >0). Since engaging in a moderate or vigorous occupation implies more exercise possibility time, the individuals with moderate or vigorous occupations are expected to have lower *BMICs* or are less likely to be obese ($\beta_{3,14}$ <0).

During the period that NLSY79 panel has been adults, housework associated with taking care of children has not required moderate or vigorous physical activity. However, for women, having children, especially younger children, requires considerable investment in supervisory activity. This frequently competes with taking time for regular moderate physically active leisure. Hence, at least for women, it is expected the number of children at home, by age group, to reduce the likelihood of participating in regular physical activity and total time on physical activity ($\beta_{1,17}$ - $\beta_{1,19}$ <0, and $\beta_{2,17}$ - $\beta_{2,19}$ <0).

MARRIED indicates the marital status of the individual, = 1 if the individual is married with spouse present in the household; = 0 otherwise. *BLACK* and *HISPANIC* are racial and ethnicity indicator variables. *BLACK* = 1 if the individual is black, = 0 otherwise. *HISPANIC* = 1 if the individual is Hispanic, = 0 otherwise. *URBAN* =1 if the individual lives in an urban area, = 0 otherwise. The impacts of these factors on LP_j , LPT_j (*j*=1, 2), *BMIC* and *OBESE* are uncertain ($\beta_{k,20} \cdots \beta_{k,23}$ > = <0 for *k*=1, 2, 3).

NE , *NC* and *SOUTH* are geographic region indicator variables. *NE* =1 if the individual lives in the northeast region, =0 otherwise. *NC* =1 if the individual lives in the north central region, =0 otherwise. *SOUTH* =1 if the individual lives in the south region, =0 otherwise. Region variables control for climatic differences that can impact opportunities for outdoor types of physical activity and food prices, particularly price of produce.

ρ_{21} , ρ_{31} , ρ_{32} are the correlation parameters in the variance covariance matrix in trivariate probit model. It is believed that if changes of factors cause rises in participation in vigorous physical activity, then participation in moderate physical activity will increase together. So ρ_{21} are expected to be positive (ρ_{21} > 0). As the individual is more and more likely to partake in vigorous physical activity or moderate physical activity, he is less and less likely to be obese because the increase of his calorie expenditure, hence ρ_{31} and ρ_{32} are expected to be negative (ρ_{31} <0, ρ_{32} <0).

CHAPTER 5. EMPIRICAL RESULTS

Empirical results from fitting the various specifications of the demand for moderate and vigorous physical activity and supply of weight for height to the refined data for 2004 are presented and discussed in this chapter. The trivariate probit model and SUR model I are fitted to 8 sub-samples and the SUR model II is fitted to 16 sub-samples (refer to Figure 4-1 and Figure 4-2 for the sub-sample details). Table 5-1 to Table 5-4 present simulated maximum likelihood estimates (SMLE) of the trivariate probit model, Table 5-5 to Table 5-8 report seemingly unrelated regression estimates (SURE) for SUR model I, and Table 5-9 to Table 5-16 display SURE for SUR model II. 21 In this chapter, discussion is focused on the effects of the health attitude measure, the effect of the respondent's personal characteristics (i.e. education, real adjusted family income, opportunity cost of time, occupation, marital status, race and ethnicity) , the effects of early weight status, and the effects of food and drink price and health care price measures. And the discussion of results places primary emphasis on working sample including number of children variables as regressors.

5.1 Trivariate Probit Model

Table 5-1 and Table 5-2 present the SMLEs of trivariate probit model for female respondents, and Table 5-3 and Table 5-4 present SMLEs for male respondents. The results in all tables report estimates obtained from fitting the model to the working and overall samples. Table 5-1 and Table 5-3 show specifications where the number of children by age group (*K5, K12, K18*) are included as explanatory variables, and Table 5-2 and Table 5-4 present the results when these variables are excluded.

[21] Because the independent variables are all the same for these three equations, the SURE is the same as the OLS estimates.

5.1.1 Regression Results for the Female Sample

Results in Table 5-1 and Table 5-2 show that if females read nutrition labels on food packages when shopping, they are more likely to participate in vigorous and moderate physical activity regularly and less likely to be obese. Women who have more years of schooling are more likely to be obese, suggesting less time for regular exercise. A female with higher real adjusted family income is more likely to participate in vigorous physical activity regularly and less likely to be obese, but her household income has no effect on her decision to participate in moderate physical activity regularly.

Prices of food and drink affect women's lifestyle choices. If the real price of fresh fruits and vegetables is higher, a woman is more likely to participate in vigorous physical activity regularly. If the real price of dairy foods or real price of alcoholic drinks is higher, the likelihood of females' being obese is reduced, whereas if the real price of fresh fruits and vegetables or the real price of nonalcoholic drinks is higher, the probability of being obese is higher. The higher the real price of processed fruits and vegetables is, the lower is the likelihood of women being obese, because these foods tend to have added fat and sweetening ingredients during processing. If the real price of health care is higher, the probability of females' being obese is reduced. Moreover, a joint test of the null hypothesis that all of the estimated coefficients of the food and drink price in equation (9) are zero is rejected. Hence, women's decisions on their health status are affected by food and drink prices significantly. The sample values of the chi-square statistics from the likelihood ratio test (LRT) and the p-values are presented in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

A woman's *BMI*25 does not significantly impact her probability of participating in vigorous or moderate physical exercise regularly, but a large *BMI*25 does significantly increase her probability of being obese in 2004. Woman who is employed in an occupation rated as requiring more demanding physical activity is more likely to report participating in moderate physical activity regularly. Hence, working in a physically demanding, for example, blue collar, job is one way for women to be more physically active, but these jobs may not pay as well as less physically demanding white color jobs. Results from the overall sample show that women who are missing occupational information tend to be more likely to partake in moderate physical activity regularly. It is well known that BMI rises with age, until late in life, and older women respondents, even within the NLSY79 cohort, are more likely to be obese in 2004.

Women with more children under age 6 are less likely to participate in vigorous physical activity regularly and more likely to be obese. Women with more children ages between 13 and 18 are less likely to participate in regular vigorous physical activity, more likely to participate in regular moderate physical activity. But children whose ages are between 6 and 12 do not significantly affect the likelihood of a women participating in regular physical activity or likelihood of being obese.

Marital status does not affect the likelihood of a female's partaking in vigorous or moderate physical activity regularly. However, married women are more likely to be obese. Women who live in urban areas are less likely to participate in vigorous or moderate physical activity regularly and are more likely to be obese. These outcomes may reflect greater crime risks associated with outdoor exercise for women in urban than other areas. Race/ethnicity does not have a significant impact on women's decisions to participate in moderate or vigorous physical activity regularly or on the likelihood of them being obese, other things equal.[22] Compared to the West, women living in the Northeast are less likely to participate in both types of physical activity regularly, and women living in the North Central are less likely to participate in moderate physical activity regularly, but region of residence does not impact significantly the probability of women being obese. Finally, the results for the overall female sample match those of the working sample where estimated coefficients have sizeable z-values.

Estimates of the cross-equation correlation of the error terms in the trivariate probit model of women's lifestyle choices show that decisions on lifestyle choices are impacted in plausible directions by shocks to these choices. The correlation of error terms between women's participating in moderate and vigorous physical regularly is positive and significantly different from zero, and the correlation between both errors terms in the physical activity participation equations and the error term in the obesity equation is negative. However, only the correlation between the error terms in the vigorous physical activity and obesity equations is statistically significant. But, a test of the null hypothesis that the three correlation coefficients of the system of lifestyle choice equations are zero, i.e., $\rho_{21} = \rho_{31} = \rho_{32} = 0$ is rejected. Hence, women's lifestyle choices are related through unmeasured factors affecting decisions. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT1), and the critical value is 7.82 at the 5% significance level.

[22] However, in the overall sample, Hispanic women are more likely to be obese than white women.

5.1.2 Regression Results for the Male Sample

Results in Table 5-3 and Table 5-4 show that if men read nutrition information on food labels, they are more likely to participate in vigorous and moderate physical activity regularly, but this indicator of healthy lifestyle preferences does not carry over their probability of being obese. Contrary to the results for women, men with more schooling are less likely to be obese. Men with higher real adjusted family income are also less likely to be obese, but family income has no effect on their probability of participating in physical activity regularly. Men who have a higher opportunity cost of time are more likely to participate in vigorous physical activity regularly, but they are also more likely to be obese.

If the real price of meat and fish is higher in the place of residence, working men are more likely to participate in vigorous physical activity regularly. But other prices do not significantly affect men's probability of participating in physical activity regularly or the likelihood of their being obese. Moreover, a joint test of the null hypothesis that all of the estimated coefficients on the food and drink prices in equation (9) are jointly zero cannot be rejected. Hence, men's choices on health status are not significantly affected by food and drink prices. The sample values of the chi-square statistics from the likelihood ratio test and the p-values are presented in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

If at age 25, men had a larger BMI, they are more likely later to be obese in 2004. But a male's early BMI does not have a significant effect on his decision to participate in either type of physical activity regularly. Men who are employed in occupations rated as requiring greater physical activity are more likely to report that they engage in vigorous physical activity regularly. Hence, work-related physical activity requirements affect men's decisions on physical activity. In addition, results from the overall sample show that men who are missing occupational information are less likely to engage in vigorous or moderate physical activity regularly. Also, as expected older men are more likely to be obese.

Number of children by age group does not significantly affect a men's decision to participate in moderate or vigorous physical activity, nor affects his likelihood of being obese. Black and Hispanic men are more likely to be obese than white men, and Hispanic men and men living in an urban area are less likely to participate in moderate physical activity regularly, but these variables do not impact the probability of them being obese significantly. Finally, the results for the overall male sample match those of the working sample where estimated coefficients have sizeable z-values.

Estimates of the cross-equation correlation of the error terms in the trivariate probit model show the correlation of men's participating in moderate and vigorous physical activity regularly is positive and significant, and the correlation of the error term in the probit equation for participating in vigorous physical activity regularly and being obese is negative. The error terms in the moderate physical activity and obesity equations are not significantly correlated. However, a test of the null hypothesis that the three correlation coefficients in the lifestyle choice model zero, i.e., $\rho_{21} = \rho_{31} = \rho_{32} = 0$ is rejected. Hence, the impact of unmeasured effects in the system of lifestyle choice equations is similar for men and women. And men's decisions on lifestyle choices are related significantly through unmeasured effects or shocks. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT1), and the critical value is 7.82 at the 5% significance level.

5.1.3 Discussion

Overall, some similarities and some major differences exist in the economic factors that are affecting women's and men's decisions to engage in healthy lifestyles. For a female, reading nutritional information when buying a food item for the first time significantly lowers her possibility of being obese, both for the working sample and the overall sample, with or without number of children variables included. But for a male, reading nutritional information does not help much with lowering the possibility of his being obese.

Higher education lowers the possibility of being obese for males, but raises the possibility of being obese for females. Adjusted family income does not have a significant effect on the likelihood of undertaking either type of physical activity for males, but it has a positive effect on the likelihood of undertaking vigorous physical activity for females. Both for males and females, higher adjusted family income lowers the likelihood of obesity.

Higher hourly wage rate lowers the possibility of obesity for females but raises the probability for a male. BMI at age 25 does not have a significant effect on respondent's decision on physical activity for both males and females, but higher BMI at age 25 increases the possibility of getting obese later for both males and females.

Food and drink prices do not have significant effects on the probability of being obese for males, but do for females. In particular, food and drink price-obesity relationship is positive for fresh fruits and vegetables and non-alcoholic drinks, negative for dairy foods, processed fruits and vegetables and alcoholic drinks. Higher price of fresh fruits and vegetables lead to higher likelihood of undertaking regular vigorous physical activity for females, but have no significant effect on exercise participation for males.

Being employed in an occupation rated as moderately or vigorously physical active increases the likelihood of participating in moderate physical activity for females. While for males, working in such an occupation increases the likelihood of participating in vigorous physical activity. Older respondents are more likely to be obese than younger respondents, for both women and men. The number of children by age group does not affect men's decision to participate in moderate or vigorous physical activity or to become obese. But for a woman, more children under age 6 increase the likelihood of being obese.

Being married increases the likelihood of being obese for a woman but does not have significant effect for man. A Hispanic/black man is more likely to be obese than his counterpart, which is not true for a Hispanic/Black woman.

5.2 Seemingly Unrelated Regression Model I

The least-squares IV estimates of SUR model I for female respondents are reported in Table 5-5 and Table 5-6, and least-squares IV estimates for male respondents are reported in Table 5-7 and Table 5-8. All tables are stratified by working and overall samples. Table 5-5 and Table 5-7 present the estimates for models including number of children by age group as explanatory variables, and Table 5-6 and Table 5-8 present estimates of models excluding the number of children regressors.

5.2.1 Regression Results for the Female Sample

Results reported in Table 5-5 and Table 5-6 indicate that a female who reads nutritional labels on food packages has a lower current BMI than a female who does not, at a magnitude of 0.427 point reduction in the working sample with number of children variables included as regressors (Table 5-5). An increase in a woman's education increases her later BMI.

A female with higher adjusted family income (*V*) usually does more vigorous physical activity and has lower current BMI. For the working sample and including explanatory variables for number of children (Table 5-5), a $100,000 increase in *V* results in an increase by about 7 hours (413 minutes) in vigorous physical activity every week and a 0.946 point reduction in current BMI. If a woman has a higher opportunity cost of time, she currently has a lower BMI. A woman with a higher BMI at age 25 also has a higher BMI currently.

Prices of food and drink affect women's life style choices. Results suggest that alcoholic drinks are substitutes for a woman's vigorous physical activity. As expected, for a woman, the price-BMI relation is negative for processed fruits and vegetables, and health care services and products; while for fresh fruits and vegetables and for non-alcoholic drinks, it is positive. A joint test of the null hypothesis that all of the estimated coefficients of the food and drink price in equation (9) are zero is rejected, indicating that women's decisions on their healthy weight are affected by food and drink prices significantly. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

Women without occupational information are shown to spend about three hours less on vigorous physical activity each week than women who reported occupational information. Older women spend less time on both types of physical activity and have higher current BMI than younger women, but only the effect on current BMI is significant. Estimates from the working sample with number of children variables reveals that one year older implies an average 0.2 point higher in current BMI for a female.

Women with more children under age 6 tends to participate in more moderate physical activity; while children who ages between 6 and 18 do not have significant effect on women's decisions on physical activity or healthy weight. Married females spend less time on both types of physical activity and have higher current BMI than single or separated females. Black/Hispanic females currently have higher BMI than their counterparts. For the working sample and including explanatory variables for number of children (Table 5-5), on average, a married woman's current BMI is 1.09 point higher than her single or separated counterpart; a black woman's BMI is 0.68 point higher than her white counterpart; a Hispanic woman's current BMI is 1.05 point higher than her non-Hispanic counterpart.

Living in an urban area does not significantly affect a female's decision on physical activity. However, women living in an urban area tend to have higher BMI currently. Living in the North Central leads to a higher current BMI than living in the west for a female, about 1 point more on magnitude.

Estimates of the cross-equation correlation of the error terms are presented in each table. It shows that participation in two types of physical activity has some positive correlations, where the correlation coefficient ranges from 0.10 to 0.20 in different sub-samples. But neither of them has a close relationship with BMI.

5.2.2 Regression Results for the Male Sample

Results reported in Table 5-7 and Table 5-8 reveal that a male who reads nutritional labels when purchasing food allocates less time to moderate and vigorous physical activity, although these impacts are not statistically significant. An increase in a man's years of schooling increases the time that he spends on vigorous physical activity, and decreases a man's BMI. For the sample of working men with number of children variables included (Table 5-7), a one more year's increase of education lowers the BMI by 0.273 in magnitude.

Male with higher adjusted family income (*V*) usually have lower BMI. For the working sample and including number of children variables as explanatory variables (Table 5-7), a $100,000 increase in *V* results in an increase by about 10 hours (617 minutes) in vigorous physical activity each week, and 0.437 less in BMI. A male's hourly wage rate and BMI at age 25 have statistically significant impacts on his time allocation to vigorous physical activity. If a male has a higher hourly wage rate or a higher BMI at age 25, he assigns less time to vigorous physical activity, thus, he has a higher BMI.

The estimates of coefficients for the food, drink and health care prices in the model imply that meat and fish, and also alcoholic drinks, are complements for a man's moderate physical activity. Non-alcoholic drinks and health care services/ products are complements for vigorous physical activity. When the price of dairy foods increase, a man's BMI will increase. A joint test of the null hypothesis that all of the estimated coefficients of the food and drink price in equation (9) are zero fails to be rejected, indicating that food and drink prices does not significantly affect men's BMI. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

Men without occupational information are shown to allocate less time to vigorous physical activity than men with occupational information. Older men have higher BMI than younger men. As shown from the estimates in the working sample including number of children as explanatory variables, one year older predicts a 0.12 higher in BMI.

The number of children (*K5, K12, K18*) does not have significant impacts on a man's time allocated to moderate physical activity or vigorous physical activity. Men with more children between 6 and 12, however, have lower BMI, by a 0.28 reduction in magnitude. Black or Hispanic males allocate less time on vigorous physical activity and moderate physical activity, and have higher BMI than their counterparts. A male living in an urban area tends to have a higher BMI than a male living in a rural area. For the working sample including explanatory variables for number of children, on average, a black man's BMI is 1.64 higher than his white counterpart; a Hispanic man's current BMI is 0.69 higher than his non-Hispanic counterpart; the BMI of a man living in an urban area is 0.35 higher than a man living in rural area. For a male, living in Northeast indicates less time allocated on vigorous physical activity than living in the West, and living in the North Central or South leads to a higher BMI than living in the West.

Estimates of the cross-equation correlation of the error terms are presented in each table. It shows that participation in two types of physical activity has positive correlations, where the correlation coefficient ranges from 0.31 to 0.34 in different sub-samples. But neither of them has a close relationship with BMI.

5.2.3 Discussion

Comparing the regression results for females in Table 5-5 and Table 5-6 with the results for males in Table 5-7 and Table 5-8, some explanatory variables have similar effects on females as on males, and some affect them differently from. Reading nutritional information lowers women's current BMI but does not have significant effect on men's current BMI. For a woman, higher education implies higher current BMI; for a man, higher education predicts more time allocated to vigorous physical activity, and hence has a lower BMI. For both females and males, higher real adjusted family income indicates lower current BMI, but the effect on current BMI is smaller in magnitude for males than for females. However, higher family income also predicts more time on vigorous physical activity for females, while it has does not affect males' decisions on physical activity.

Higher hourly wage rate tends to lower a female's current BMI but raise a male's current BMI; higher hourly wage rate predicts less time on vigorous physical activity for a male but does not have significant impact on a female's physical activity. A man with higher BMI at age 25 spends less time on vigorous physical activity, while a woman's BMI at age 25 does not significantly affect her decision on participation in vigorous physical activity. However, higher BMI at age 25 predicts higher current BMI for both women and men.

For females, price-BMI relationship is positive for fresh fruits and vegetables and non-alcoholic drinks, negative for processed fruits and vegetables and health care services and products. While for males, price-BMI relationship is positive for dairy food. Joint test results show that the prices of food and drinks have significant effects on female's BMI, but not on male's BMI.

Engaging in a moderate or vigorous occupation does not significantly affect a female's or male's physical activity decision or his or her current BMI. Respondents without occupational information are shown to spend less time on vigorous physical activity for both males and females, but only indicate higher BMI for males. Older respondents tend to have higher current BMI than younger respondents for both females and males.

Number of children in each age group does not affect a male's physical activity decision but more *K5* indicates more time on moderate physical activity for a female; number of children in each age group does not affect a female's BMI but more *K12* indicates lower BMI for a male. Marital status does not affect a man's decisions on physical activity or his BMI, but a married woman spends less time on both types of physical activity and has a higher BMI than a single woman. Results suggest that for both males and females, Hispanic respondents have higher current BMI than non-Hispanic respondents. Race and ethnicity do not have significant effects on either type of physical activity for females. However, black males spend less time on vigorous physical activity than white males, and Hispanic males spend less time on both types of physical activity than non-Hispanic males.

Those geographic area indicator variables affect males and females similarly too. Living in the North Central leads to a lower current BMI than living in the West for men and women. In addition, for a man, living in the South results in a higher current BMI than living in the West.

5.3 Seemingly Unrelated Regression Model II

SUR model I takes *BMI25* as one of the explanatory variables, while SUR model II partitions the sample by whether the individuals were overweight at age 25. This helps to study how different early weight groups respond to changes of explanatory variables. Table 5-9 to Table 5-12 show least-squares IV estimates of SUR model II for female respondents, while Table 5-13 to Table 5-16 display least-squares IV estimates for male respondents. Each table is stratified by early overweight sample and early non-overweight sample. Table 5-9 to Table 5-10 and Table 5-13 to Table 5-14 present the estimates for specifications where the number of children by age groups are included as explanatory variables, while Table 5-11 to Table 5-12 and Table 5-15 to Table 5-16 present the estimates for specifications without number of children variables.

5.3.1 Regression Results for the Female Sample

Results reported in Table 5-9 to Table 5-12 indicate that reading nutritional information has no significant effects on a female's decision on physical activity, or on her current BMI. This is true for both the early overweight group and early non-overweight group. If a female was non-overweight at age 25, then higher education leads to higher current BMI. An increase in adjusted family income decreases current BMI for all females, but the estimate is larger in magnitude for the overweight group than for the non-overweight group. For the working sample and including explanatory variables for number of children (Table 5-9), an addition $100,000 of *V* results in a 3.579 reduction in current BMI for an early overweight female, but only a 0.871 reduction for an early non-overweight female. For females who were non-overweight at age 25, higher adjusted family income predicts more time allocated to vigorous physical activity, with over 7 hours (457 minutes) more each week on vigorous physical activity for each increase of $100,000 in *V* according to estimates from the working sample and including explanatory variables for number of children (Table 5-9). Higher opportunity cost of time results in lower current BMI for early non-overweight females, but does not have statistically significant effect on early overweight females.

The estimates of coefficients for the food, drink and health care prices suggest different effects for early overweight female group and early non-overweight female group. For the early overweight females, some are substitutes for physical activity, such as fresh fruits and vegetables, and non-alcoholic drinks for vigorous physical activity, while health care services or products for moderate physical activity. Some are complements for physical activity, such as meat and fish, and dairy foods for vigorous physical activity, and processed fruits and vegetables for moderate physical activity. However, for the early non-overweight females, it is only found that the non-alcoholic drinks and fast foods are complements for vigorous physical activity.

For early overweight females, none of the price-BMI relation is significant. While for early non-overweight females, price-BMI relation is positive for fresh fruits and vegetables and non-alcoholic drinks, and negative for processed fresh fruits and vegetables. A joint test of the null hypothesis that all of the estimated coefficients of the food and drink price in equation (9) are zero fails to be rejected for the early overweight samples, but get rejected for the early non-overweight samples. This result indicates that food and drink prices do not significantly affect a female's BMI if she was overweight at age 25, but does affect a female's BMI if she was not overweight at that age. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

Whether or not being employed in a moderate or vigorous occupation does not affect a female's physical activity decision or her current BMI. Given other conditions the same, early overweight females without occupational information have higher current BMI than early overweight females with occupational information; and early non-overweight females without occupational information tend to spend less time on vigorous physical activity than early non-overweight females with occupational information.

For early overweight females, older age implies higher current BMI, but for early non-overweight females, age does not have significant impacts on either physical activity or current BMI for the NLSY79 cohort. Taking the estimates from the working sample with number of children variables for instance (Table 5-9), an additional year of age leads to a 0.301 increase in current BMI for early overweight females.

Estimates show that if a female has more children under age 6 (*K5)*, she allocates more time on moderate physical activity, conditional on that she was not overweight when she was 25 years old. However, number of children in the other two age groups does not have significant effects on either physical activity or current BMI for both female groups.

Marital status has similar effects on a female's current BMI for the early overweight females and the early non-overweight females. A married female has a higher current BMI than a single or separated female, no matter she was overweight or not. For the early non-overweight females, being married also indicates less time allocated on both types of physical activity. Early overweight black females tend to have higher BMI than early overweight white females, but early non-overweight black females tend to have lower BMI than early non-overweight white females. Early non-overweight Hispanic females are shown to have higher BMI than early non-overweight non-Hispanic females.

A female living in an urban area has a lower current BMI than the female living in a rural area if she was overweight at younger age (25), but she has a higher current BMI f she was not overweight at her younger age. For an early non-overweight woman, living in the Northeast or North Center or South lowers her current BMI compared with that living in the West.

Estimates of the cross-equation correlation of the error terms are presented in each table. It indicates that participation in two types of physical activity has positive correlations both for the early overweight group and the early non-overweight group, and the correlation coefficients are very close in magnitude for these two groups, ranging from 0.10 to 0.14 in different sub-samples. However, neither type of physical activity has a close relationship with BMI for both groups.

5.3.2 Regression Results for the Male Sample

Reading nutritional information is shown to have no significant effects on a male's current BMI or his decision on physical activity, no matter he was overweight or not. If a male was overweight when he was 25 years old, higher education leads to higher current BMI; while if a male was non-overweight at age 25, higher education suggests more time on vigorous physical activity, and lower current BMI. Real adjusted family income does not have significant effect on current BMI for a man, but higher adjusted family income indicates more time on vigorous physical activity for early non-overweight men. Higher opportunity cost of time results in lower current BMI for early overweight men, but less time on vigorous physical activity thus higher current BMI for early non-overweight men.

The results of the price variables on physical activity suggest different effects for early overweight males and early non-overweight males. For early overweight males, non-alcoholic drinks and fast food are complements for vigorous physical activity. But for early non-overweight males, health care services or products are complements for vigorous physical activity, alcoholic drinks are complements for moderate physical activity, and processed fruits and vegetables are substitutes for moderate physical activity.

For early non-overweight males, none of the price-BMI relations is significant. While for early overweight males, price-BMI relation is positive for dairy food and fast food. A joint test of the null hypothesis that all of the estimated coefficients of the food and drink price in equation (9) are zero fails to be rejected for both the early overweight male sample and early non-overweight male sample. This indicates that food and drink prices do not significantly affect a man's BMI no matter he was overweight or not when he was 25 years old. The sample values of the chi-squared statistics and the p-values are shown in each table (LRT2), and the critical value is 14.07 at the 5% significance level.

Results show that occupational physical activity does not affect man's decision on leisure physical activity. For both early overweight males and non-overweight, older age implies higher current BMI, with larger effects for overweight males than non-overweight males in magnitude. For an early overweight man, more children of age between 13 and 18 (*K18*) leads to a higher current BMI, while for an early non-overweight man, more children of age under 6 (*K5*) or between 6 and 12 (*K12*) results in a lower current BMI.

A married male has generally a higher current BMI than a single or separated male if he was overweight at age 25. For the early overweight group, the black/Hispanic males tend to have lower current BMI than the white/non-Hispanic males, but for the early non-overweight group, the black/Hispanic males tend to spend less time on vigorous physical activity and thus have higher BMI than white/ non-Hispanic males.

Living in an urban area does not have significant effects on physical activity or current BMI for early overweight males, but early non-overweight males living in an urban area have higher BMI than those living in a rural area. For an early overweight male, living in the Northeast or North Central or South will cause him to have a higher BMI than living in the West. For an early non-overweight male, living in the Northeast leads to less time on vigorous physical activity than living in the West.

Estimates of the cross-equation correlation of the error terms are presented in each table. It indicates that participation in two types of physical activity has strong positive correlations for the early non-overweight group, where the correlation coefficients range from 0.49 to 0.55. But this correlation coefficient is very small for the early overweight group, ranging from 0.02 to 0.03. For the early overweight males, it is also found some negative correlations between participation in the vigorous physical and current BMI, but the coefficient is still small, ranging from -0.05 to -0.07.

5.3.3 Discussion

After partitioning the samples into early overweight group and early non-overweight group, reading nutritional information is shown to have no effect on either physical activity or current BMI (*BMIC*) for both males and females. For females, higher education implies higher *BMIC* for the early non-overweight group, but for males, higher education implies higher *BMIC* for the early overweight group but lower *BMIC* for the early non-overweight group.

Higher adjusted family income indicates lower *BMIC* for females but doe not have significant effect on males. Hourly wage rate or opportunity cost of time has different impacts on *BMIC* for females and males. For females, higher hourly wage leads to lower *BMIC* for the early non-overweight group, but for males, higher hourly wage leads to lower *BMIC* for the early overweight group, and higher *BMIC* for the early non-overweight group.

Results show that some food items affect females and males similarly. For instance, non-alcoholic drinks and fast food are complements for vigorous physical activity for early overweight males and early non-overweight females; fresh fruits and vegetables are shown as substitutes for vigorous physical activity for early overweight females and early non-overweight males. However, health care services or products affect females and males very differently. They are substitutes for moderate physical activity for early overweight females, but complements for vigorous physical activity for early non-overweight males. In addition to the difference of impacts on physical activity, there exists significant difference of impacts of price variables on *BMIC* for males and females. Test results show that food and drink prices jointly do not affect male's *BMIC* but significantly affect non-overweight female's *BMIC*.

Age affects females and males similarly. Older age implies higher *BMIC* for the early overweight group for both females and males. Considering the non-overweight group, a woman's physical activity decision is affected by her marital status but a man's decision is not affected by his marital status. Considering the overweight group, it is found that married individual has generally a higher current BMI than a single or separated individual, which is true for both females and males.

For the female sample, participation in two types of physical activity has some positive correlations for the both overweight and non-overweight groups. However, the correlation is not strong, with coefficient ranging from 0.10 to 0.14. For the male sample, participation in two types of physical activity has very strong positive relationship for the early non-overweight group, but this correlation is very small for the early overweight group.

5.4 Comparison of the Three Models

5.4.1 Comparison of Regression Results for the Female Sample

When the trivariate probit model is fitted to the female sample, reading nutritional information on the food labels is shown to have significantly positive effect on both types of physical activity and significantly negative effect on obesity status. When SUR model I is fitted to the female sample, reading nutritional information is shown to significantly lower a female's current BMI, but have no significant effects on her decisions on either type of physical activity. However, when SUR model II is fitted to the female sample, reading nutritional information have no significant impacts on either physical activity or current BMI.

The results from the trivariate probit model show that higher education results in higher likelihood of obesity for a female, and SUR model I reveals similar results, while SUR model II shows that higher education causes a higher BMI for a female only if she was not overweight when she was 25 years old.

All three models provide consistent findings that a higher family income has a negative effect on a female's current BMI. For example, both SUR models show that higher adjusted family income leads to a lower current BMI, and the trivariate probit model shows that a female with higher adjusted family income is less likely to be obese. In addition, both the trivariate probit model and SUR model I show that adjusted family income positively affect a female's decision on vigorous physical activity, but SUR model II shows this effect is significant only for early non-overweight females.

The results from the trivariate probit model and SUR model I provide similar findings that the hourly wage rate or opportunity cost of time negatively affects a female's current

BMI. For instance, the results in the trivariate probit model shows that a female with a higher hourly wage rate is less likely to be obese, and SUR model I reveals that a female with higher hourly wage rate tends to have lower current BMI. However, the results from SUR model II suggest that a higher hourly wage rate leads to a lower current BMI only for the early non-overweight females, but do not have a significant impact on BMI for the early overweight females. Results from both the trivariate probit model and SUR model I imply that a higher *BMI25* leads to higher likelihood of obesity or higher current BMI for females.

Estimates from trivariate probit model and SUR model I reveal that a few food and drink prices have significant effects on physical activity, but results from SUR model II show that a lot of food and drink prices significantly impact female's decisions on physical activity. For example, when the models are fitted to the working female sample with numbers of children included, the trivariate probit model shows that fresh fruits and vegetables are substitutes for vigorous physical activity. SUR model I reveals that alcoholic drinks are substitutes for vigorous physical activity. However, the results from SUR model II show that for early overweight females, meat and fish and dairy foods are complements for vigorous physical activity; fresh fruits and vegetables and non-alcoholic drinks are substitutes for vigorous physical activity; processed fruits and vegetables are complements for moderate physical activity; dairy foods and health care services or products are substitutes for moderate physical activity. For early non-overweight females, non-alcoholic drinks and fast foods are complements for vigorous physical activity.

The results across trivariate probit model and two SUR models show a number of differences when it comes to the price-BMI/obesity relation. Trivariate probit model and SUR model I reveal many significant price-BMI/obesity relations, and conclude that the food and drink prices jointly have significant effects on a female's obesity status or her current BMI. Whereas SUR model II does not find significant price-BMI relations for early overweight females, and concludes that the food and drink prices jointly do not have significant effects on their current BMI. However, for the early non-overweight female sample, the results does yield significant price-BMI relations, and conclude that food and drink prices have significant effects on their current BMI. A few results are similar across all three models: positive price-BMI/obesity relations for fresh fruits and vegetables and non-alcoholic drinks, and negative price-BMI/obesity relation for processed fruits and vegetables.

Only the results for the trivariate probit model show that a female's occupation affects her decision on leisure-time physical activity, indicating that a female working on an occupation rated as involving moderate or vigorous physical activity is more likely to do moderate physical activity. While the other two SUR models show that a female's occupation does not affect her decisions on physical activity.

From the trivariate probit model and SUR model I, the conclusion can be drawn that females with older age have higher current BMI or higher likelihood of being obese, but in SUR model II it is true only for early overweight females. Hence, for all three models, it can be concluded that married females have higher current BMI or higher likelihood of being obese for females. From the trivariate probit model and SUR model II (for non-overweight females), a conclusion can be drawn that being married negatively affect female's physical activity decisions. All three models show that participation in two types of physical activity is positively related, and these decisions do not have close relations with female's BMI or her obesity status.

5.4.2 Comparison of Regression Results for the Male Sample

None of the results from the three models shows that reading nutritional information on food labels significantly affects male's decisions on a healthy weight, but results from the trivariate probit model shows that men reading nutritional labels are more likely to participate in both types of physical activity. Results from both the trivariate probit model and SUR model I imply that higher education results in lower likelihood of obesity or lower current BMI for males, and results from the SUR model I reveal similar results but only for the early non-overweight males. For the early overweight males, the results show that higher education leads to a higher BMI. Results from both SUR models show that men with higher education allocated more time to vigorous physical activity, although for SUR model II it is true only for early non-overweight males.

The results of the trivariate probit model and SUR model I reveal that a male with higher adjusted family income is less likely to be obese and has a lower current BMI, while the results of SUR model II show that household income does not have a significant effect on a male's current BMI. From the trivariate probit model and SUR model I, a male with a higher hourly wage rate or opportunity cost of time is more likely to be obese or to have a higher current BMI. Results from SUR model II lead to a similar conclusion for the early non-overweight males, but for the early overweight males, it shows that higher opportunity cost of time leads to lower BMI. Results from SUR model I show that the hourly wage rate negatively affects a male's decision on vigorous physical activity, and results from SUR model II lead to the same conclusion for early non-overweight males. The results from the trivariate probit model and SUR model I also show that males with higher BMI at age 25 are more likely to be obese or to have a higher current BMI.

Results from all three models imply that the non-alcoholic drinks are complements for vigorous physical activity, but for the SUR model II, the results are significant just for the early overweight group. Results from the trivariate probit model show that none of the food or drink prices significantly affects the likelihood of a male's being obese. Results from both SUR models show that an increase of the price of dairy food results in an increase in current BMI for a man, and SUR model II further shows that a rise of the price of fast food leads to an increase in current BMI for the early overweight male group.

The results from the trivariate probit model show that a male engaging in an occupation requiring moderate or vigorous activity is more likely to report participating in vigorous physical activity. But results from the SUR models do not support this result. Given the results of all three models, a conclusion can be drawn that older males have higher current BMI or higher likelihood of being obese. Black/Hispanic males are shown to spend less time on vigorous physical activity and thus have higher BMI or higher likelihood of being obese than white/non-Hispanic males for all the three models, but in SUR model II this result occurs only for early non-overweight males.

From the results of the trivariate probit model and SUR model I, it can be concluded that male's participation in two types of physical activity are positively associated and the correlation is very strong. But for the SUR model II, the same conclusion can be only drawn for the early non-overweight group.

CHAPTER 6. CONCLUSIONS

Does a person's health attitude affect his/her decision on participation in physical activity and his/her weight status? Does a person's early weight status affect his/her decision on physical activity or his/her current weight status? Is a particular food or drink, such as meat and fish, fresh fruits and vegetables, processed fruits and vegetables, alcoholic drinks, non-alcoholic drinks, and fast food, a substitute or a complement for an individual's physical activity? Are the health care services and products substitutes for an individual's physical activity? Are decreases in the prices of those food or drink responsible for increases in an individual's BMI? This paper presents estimates of the causes of participation in two types of physical activity and the precipitating factors of obesity or BMI focusing on health attitude, prices of food, drink and health care services and products, the respondent's personal characteristics (such as education, adjusted family income, opportunity cost of time, occupation, marital status, race and ethnicity) and the respondent's early weight status. The individual's food and drink consumption and exercise tastes are controlled by a small cohort spanning 8 years and the individual's race and ethnicity.

A trivariate probit model and two SUR models are explored in this paper to study individual's decisions on physical activity and energy imbalance for a panel of middle-aged adults. Trivariate probit model focuses on the respondent's decisions on regular vigorous physical activity and regular moderate physical activity and his current obesity status. While two SUR models focus on the respondent's decisions on total time allocated to vigorous physical activity and moderate physical activity and his current BMI. Trivariate probit model and SUR model I share the same independent variables, and both use the variable *BMI25* to indicate the respondent's early weight status. However, SUR model II attempts to capture how individuals of different early weight groups respond to changes. So the sample was partitioned into early overweight group and early non-overweight group according to the respondent's overweight status at age 25. SUR model II has the same independent variables except for *BMI25* which is excluded to avoid the problem of endogeneity.

The three models are fitted to a large cross of middle-aged (ages 39-47) adults taken from the National Longitudinal Survey of the Youth 1979 Cohort, 2004 round. External price data are obtained from the American Chamber of Commerce Research Association (ACCRA) Cost of Living Index. Some similar results are found in the three models. For example, all the three models conclude that: (1) higher adjusted family income leads to a lower current BMI or a lower likelihood of being obese for both males and females; (2) females with higher education are more likely to be obese or have higher BMI, while males with higher education are less likely to be obese or have lower BMI; (3) males with older age have higher current BMI or higher likelihood of being obese; (4) price-BMI/obesity relations for fresh fruits and vegetables and non-alcoholic drinks are positive for females; (5) price-BMI/obesity relation for processed fruits and vegetables is negative for females.

Three different types of empirical models have been fitted to explain individuals' choices on physical activity and obesity. First, results from a trivariate probit model showed that if an individual reads nutritional labels on food packages he/she is significantly more likely to undertake both types of physical activity, and for women, they are significantly less likely to be obese. Results from the SUR model I showed that reading nutritional information significantly lowers current BMI for females; while results from SUR model II showed that reading nutritional information has no significant effects on decisions to participate in vigorous or moderate physical activity regularly or on current BMI for both males and females.

Second, results from the trivariate model do not show a significant effect of an individual's education on choice of physical activity, but results for both SUR models show that higher education results in more time allocated to vigorous physical activity for males, although this is only true for the early non-overweight group in SUR mode II. The findings from SUR models are consistent with the conclusion of Gidow et.al (2006) about positive partial correlations between an individual's education and participation in physical activity only for male samples and only for vigorous physical activity. There was no significant positive relationship between education and the decision to participant in moderate physical activity regularly.

Third, results from the trivariate probit model and SUR model I reveal that the food and drink prices jointly and significantly affect the obesity status or BMI for a female, but not for a male. Results from SUR model II provide a similar conclusion only for the non-overweight females.

Finally, results from trivariate probit model provide more interesting findings about the food price-obesity relation for females. In addition to the positive price-obesity relations for fresh fruits and vegetables and non-alcoholic drinks and negative price-obesity relation for processed fruits and vegetables, it also predicts negative price-obesity relations for dairy foods and alcoholic drinks. The findings for fresh fruits and vegetables are consistent with Auld and Powell (2008), who found that the price of fruits and vegetables is highly positively associated with BMI and the price effect of fruits and vegetables is particularly strong for female respondents. But their paper did not separate fresh fruits and vegetables from processed fruits and vegetables, which is a disadvantage of their particular commodity groupings. The findings for the price of dairy foods contradict Asfaw (2007), who concluded that a positive relation between price of milk and eggs and BMI/obesity exists. However, results from SUR model I provide support for Asfaw when it comes to the male sample, and SUR model II too, for the early overweight males. The findings for the prices of fresh and processed fruits and vegetables are consistent with Etilé (2008), who found positive effect of prices for fruits and vegetables in brine on BMI, and negative effect when these products are processed.

SUR model II has some interesting findings about the impacts of prices of food, drink and health services or products on physical activity. For example, for the early overweight females, meat and fish and dairy foods are complements for vigorous physical activity; fresh fruits and vegetables and non-alcoholic drinks are substitutes for vigorous physical activity; processed fruits and vegetables are complements for moderate physical activity; dairy foods and health care services or products are substitutes for moderate physical activity. For the early non-overweight females, non-alcoholic drinks and fast foods are complements for vigorous physical activity. For the early overweight males, non-alcoholic drinks and fast foods are complements for vigorous physical activity. For the early non-overweight males, fresh fruits and vegetables are substitutes for vigorous physical activity, while processed fruits and vegetables are substitutes for moderate physical activity; health care services or products are complements for vigorous physical activity, while alcoholic drinks are complements for moderate physical activity.

The SUR model II also has some interesting results on the impact of prices on a respondent's current BMI, and some of which are consistent with Auld and Powell (2008), such as the price of fresh fruits and vegetables is positively associated with body weight for the non-overweight women, while some of which contradict with Auld and Powell (2008). For instance, a rise of the price of fast food results in a higher current BMI for an early overweight man, which this is consistent with Etilé (2008).

Although the three lifestyle outcome equations are not a system of simultaneous equations, they are an exact type or similar to a seemingly-unrelated regression model. That is, the decisions are permitted to be related through the error terms. The results show that the size of the cross-equation correlation of error terms is up to 0.56, quite large. Hence, efficiency of estimation was gained by fitting a system of equations rather than each equation separately.

From a policy's respective, if taxes and subsidies are to be used to reduce the percentage of obesity, the regression results suggest that taxing processed fruit and vegetables, together with subsidizing consumption of fresh fruit and vegetables, and non-alcoholic drinks, may reduce the current prevalence of obesity, with a corresponding reduction in health-care costs. On the other hand, the regression results suggest that policies which affect the consumption of meat and fish will not be effective in relieving the obesity problem. Since the results show that men are less price-responsive than women, these policies are expected to affect the consumption structure of households where women takes the most responsibility for grocery shopping for the whole family, and hence will benefit such households in the sense of reducing the possibility of household members' getting obese.

Estimates in this paper are limited in that the height, weight and physical activity levels are all from the self-reported data, and food and drink and health care products prices are treated as exogenously assigned conditional on observable characteristics. Demand–

driven variation in prices that remains after conditioning on observable characteristics will bias my estimates.

REFERENCES

Ainsworth, B. E. 2003. The Compendium of Physical Activities. *Presidents Council on Physical Fitness and Sports Research Digest*, series 4, No. 2

Asfaw, A. 2007. Do Government Food Price Policies Affect the Prevalence of Obesity? Empirical Evidence from Egypt. *World Development*, Vol **35**: 687-701

Auld, C. and L. Powell .2008. Economics of food energy density and adolescent body weight, *Economica*, forthcoming.

Beyer, N.K., S.M. Nusser, W.A. Fuller, A.L. Carriquiry and G.J. Welk. 2007. Survey Design for Studies of Measurement Error in Physical Activity Assessments. *Proceedings of the Section on Survey Research Methods,* American Statistical Association.

Booth, F.W. and M.V. Chakravarthy 2002. Cost and Consequences of Sedentary Living:New Battleground for an Old Enemy. *Presidents Council on Physical Fitness and Sports Research Digest.* series 3, No. 16

Cawley, J. 2000. Bodyweight and women's labor market outcomes. NBER Working Paper Series, Vol. **w7841.pp.-2000**

Cawley, J. 2004. The Impact of Obesity on Wages. *Journal of Human Resources* **39**: 451- 474

Etilé, F. 2008. Food Price Policies and the Distribution of Body Mass Index: Theory and Empirical Evidence from France. Working Paper, Health, Econometrics and Data Group, Department of Economics, University of York

Gidlow, C., L.H.Johnston, D.Crone, N.Ellis and D.James.2006. A systematic review of the relationship between socio-economic position and physical activity. *Health Education Journal* **65**:338-367

Grossman, M. 2000. The Human Capital Model. In *Handbook of Health Economics*, vol1A, A. J. Culter and J.P. NewHouse(eds). New York, NY: Elsevier, 248-408

Heckman, J.J. 1979 Sample Selection Bias as a Specification Error. *Econometrica*, Vol. **47**: 153-161

Huffman, W.E. 2001. Human Capital: Education and Agriculture. *Handbook of Agricultural Economics*, Vol. IA, Bruce L. Gardner and Gordon C. Rausser(eds). Amsterdam, Netherlands: Elsevier Science/North-Holland, 333-81.

Huffman, W.E., S.K. Huffman, A. Tegene, and K. Rickertsen. 2006. The Economics of Obesity-Related Mortality Among High Income Countries, *American Agricultural Economics Association Meeting*, and *the International Association of Agricultural Economics Meeting*.

Judge, G. G., W. E. Griffiths, R. C. Hill, H. Lutkepohl and T. Lee. 1985. *The Theory and Practice of Econometrics*. New York: John Wiley and Sons.

Kaplan, G.A., W.J. Strawbridge and R.D. Cohen, *et al.* 1996. Natural history of leisure-time physical activity and its correlates: Associations with mortality from all causes and cardiovascular disease over 28 years. *American Journal of Epidemiology* **144**: 793-97.

Khaw, K., N. Wareham, S. Bingham, A. Welch, R. Luben, and N. Day. 2008. Combined Impact of Health Behaviours and Mortality in Men and Women: The EPIC-Norfolk Prospective Population Study. *PLoS Medicine* **5**: 39-47.

Kujala, U.M., J. Kaprio and S. Sarna, *et al.* 1998. Relationship of leisure time physical activity and mortality: The Finnish twin cohort. *Journal of the American Medical Association* **279**: 440-44.

Kushi, L.H., R.M. Fee and A.R. Folsom, et al.1997. Physical activity and mortality in postmenopausal women. *Journal of the American Medical Association* **277**: 1287-92.

Landers**,** D. M. 1997. The Influence of Exercise on Mental Health. *Presidents Council on Physical Fitness and Sports Research Digest*, series 2, No. 12

Lee, I.M. and R.S. Paffenbarger. 2000. Associations of Light, Moderate, and Vigorous Intensity Physical Activity with Longevity. American Journal of Epidemiology **151**: 293-99.

National Heart, Lung, and Blood Institute, National Institutes of Health. 1998. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults-the evidence report. *Obesity Research* **6**: 51S–215S

Nelson, M.C, P. Gordon-Larsen, K. E. North and L. S. Adair. 2006. Body Mass Index Gain, Fast Food, and Physical Activity: Effects of Shared Environments over Time. *Obesity* **14**: 701-709.

Pate, R.R., M. Pratt, S.N. Blair and W.L Haskell et al.1995. Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association* **273**: 402-07.

Powell, L.M., M.C. Auld, F.J. Chaloupka, P.M. O'Malley and L.D. Johnston. 2006. Access to Fast Food and Food Prices: Relationship with Fruit and Vegetable Consumption and Overweight among Adolescents. Working Paper, Institute for Health Research and Policy, University of Illinois at Chicago.

Rosenzweig, M.R. and T.P. Schultz 1982. The Behavior of Mothers as Inputs to Child Health: The Determinants of Birth Weight, Gestation, and Rate of Fetal Growth. In *Economic Aspects of Health*, *National Bureau of Economic Research Conference Report*, V.R. Fuchs (ed). The University of Chicago Press, 53-92

Schultz, T.W. 1975. The Value of the Ability to Deal with Disequilibria.*Journal of Economic Literature* **13**: 827-846.

Seelfeldt, V. , R.M. Malina and M.A. Clark. 2002. Factors Affecting Levels of Physical Activity in Adults. *Sports Medicine* **32**:143-168

Sherman, S.E., R.B. DAgostino and J. L. Cobb, *et al.* 1994. Physical activity and mortality in women in the Framingham Heart Study. *American Heart Journal* **128**: 879-84.

Sturm, R. 2002. The Effect of Obesity, Smoking, and Drinking on Medical Problems and Costs. *Health affairs* **21**: 245-54.

Thakur, N. 2006. Can You Afford to Exercise? Effects of Time and Money Income on Physical Activity and the Body Mass. *Annual meeting of the Economics of Population Health: Inaugural Conference of the American Society of Health Economists,* TBA, Madison, WI, USA

U.S. Department of Health and Human Services. 1996. Physical Activity and Health: A Report of the Surgeon General.

U.S. Department of Health and Human Services and U.S. Department of Agriculture. 2005. The Dietary Guidelines for Americans 2005.

World Health Organization. 2000. Obesity Preventing and Managing the Global Epidemic, *WHO Technical Report* No.894

Zarkin, G.A., N. Dean, J.A. Mauskopf, and R. Williams. 1993. Potential Health Benefits of Nutrition Label Changes. *American Journal of Public Health*. **83**: 717-724.

Table 5-1: Simulated Maximum Likelihood Estimates of the Trivariate Probit Model: Female Sample

Variable	Working Sample(N=2,130)						Overall Sample (N=2,775)					
	LP1		*LP2*		*OBESE*		*LP1*		*LP2*		*OBESE*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	0.411	6.968	0.250	4.297	-0.140	-1.934	0.401	7.712	0.215	4.213	-0.127	-1.999
EDU	-0.021	-0.278	-0.030	-0.399	0.270	2.520	0.001	0.014	-0.012	-0.194	0.359	3.867
V	0.205	2.544	-0.057	-0.708	-0.506	-3.069	0.216	3.939	0.003	0.049	-0.397	-3.660
ln(*WAGE*)	0.527	0.749	0.339	0.491	-2.643	-2.676	0.356	0.608	0.248	0.434	-3.274	-3.828
BMI25	0.002	0.308	0.008	1.067	0.232	18.029	-0.004	-0.605	-0.003	-0.530	0.216	20.278
PMF	-0.196	-0.366	-0.415	-0.782	0.147	0.224	-0.341	-0.725	-0.434	-0.938	0.317	0.552
PDAIRY	-0.822	-1.233	-0.627	-0.955	-1.831	-2.229	-1.093	-1.857	-0.597	-1.039	-1.669	-2.332
PFFV	0.890	2.056	0.534	1.259	1.566	2.901	0.863	2.233	0.294	0.785	1.175	2.474
PPFV	-0.065	-0.100	-0.400	-0.626	-1.530	-1.937	0.506	0.892	-0.056	-0.102	-1.469	-2.158
PALC	-0.093	-0.164	0.476	0.852	-1.354	-1.913	-0.116	-0.230	0.620	1.247	-1.212	-1.935
PNALC	0.301	0.401	0.433	0.589	2.458	2.651	0.263	0.399	0.209	0.327	2.641	3.340
PFF	0.192	0.252	-0.482	-0.643	-0.309	-0.327	0.555	0.822	-0.931	-1.412	-0.427	-0.516
PHC	0.215	0.532	0.397	0.995	-0.993	-1.971	-0.027	-0.076	0.461	1.318	-0.807	-1.825
MVOCCU	0.050	0.509	0.237	2.513	0.029	0.253	0.058	0.596	0.270	2.907	0.073	0.637
NOCCU							-0.080	-1.262	0.112	1.825	-0.056	-0.711
AGE	-0.017	-1.285	0.019	1.435	0.053	3.177	-0.018	-1.543	0.012	1.095	0.059	4.078
K5	-0.158	-1.542	0.081	0.826	0.207	1.726	-0.135	-1.676	0.073	0.951	0.236	2.457
K12	-0.049	-0.998	0.065	1.352	-0.025	-0.395	-0.013	-0.313	0.062	1.511	-0.039	-0.732
K18	-0.038	-1.037	0.068	1.923	-0.049	-1.097	-0.061	-1.927	0.038	1.245	-0.047	-1.238
MARRIED	-0.019	-0.264	0.029	0.404	0.301	3.074	-0.019	-0.313	0.057	0.953	0.282	3.555
BLACK	-0.089	-0.679	-0.045	-0.346	0.004	0.023	-0.082	-0.737	-0.090	-0.829	-0.063	-0.421
HISPANIC	0.031	0.351	0.036	0.415	0.173	1.573	0.069	0.889	0.035	0.457	0.223	2.306
URBAN	-0.118	-1.261	-0.149	-1.621	0.268	2.164	-0.053	-0.668	-0.041	-0.533	0.312	2.857
NE	-0.394	-2.153	-0.350	-1.949	-0.214	-0.942	-0.338	-2.131	-0.300	-1.947	0.024	0.125
NC	-0.170	-0.943	-0.288	-1.627	0.128	0.549	-0.105	-0.671	-0.230	-1.522	0.297	1.464
SOUTH	-0.171	-0.870	-0.298	-1.546	0.047	0.188	-0.123	-0.723	-0.252	-1.527	0.275	1.259
Intercept	-3.585	-0.857	-3.154	-0.770	8.489	1.445	-2.764	-0.793	-1.974	-0.581	11.261	2.214

Table 5-1: Simulated Maximum Likelihood Estimates of the Trivariate Probit Model: Female Sample (Continued)

Variable	Working Sample(N=2,130)						Overall Sample (N=2,775)					
	LP1		*LP2*		*OBESE*		*LP1*		*LP2*		*OBESE*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
Rho21[23]	0.360	11.479					0.372	13.782				
Rho31[24]	-0.065	-1.502					-0.019	-0.510				
Rho32[25]	-0.046	-1.106					-0.009	-0.249				
-Log Likelihood	3453.414						4485.862					
LRT1 [26]	117.703						164.043					
LRT2 [27]	16.28						18.22					

[23] Estimates for ρ_{21} in the variance and covariance matrix.

[24] Estimates for ρ_{31} in the variance and covariance matrix.

[25] Estimates for ρ_{32} in the variance and covariance matrix.

[26] Result of Likelihood Ratio Test for $H_0 : \rho_{21} = \rho_{31} = \rho_{32} = 0$, gives the Chi-square statistics, and the p-value is indicated in parentheses.

[27] Result of Joint Test for all the coefficients for food price variables in the OBESE equation are jointly equal to zero, gives the Chi-square statistics.

Table 5-2: Simulated Maximum Likelihood Estimates of the Trivariate Probit Model: Female Sample, Without Number of Children Variables

Variable	Working Sample (N=2,290)						Overall Sample (N=2,987)					
	LP1		*LP2*		*OBESE*		*LP1*		*LP2*		*OBESE*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	0.438	7.704	0.242	4.328	-0.150	-2.156	0.422	8.406	0.214	4.366	-0.142	-2.330
EDU	-0.024	-0.324	-0.046	-0.641	0.237	2.316	0.005	0.075	-0.013	-0.214	0.332	3.760
V	0.151	2.036	-0.026	-0.347	-0.440	-2.917	0.180	3.522	0.016	0.311	-0.342	-3.461
ln(*WAGE*)	0.555	0.826	0.526	0.799	-2.313	-2.449	0.306	0.545	0.270	0.491	-3.006	-3.687
BMI25	0.004	0.539	0.004	0.525	0.231	18.884	-0.003	-0.562	-0.006	-0.981	0.215	21.288
PMF	-0.407	-0.791	-0.143	-0.282	-0.072	-0.115	-0.540	-1.190	-0.412	-0.925	0.181	0.328
PDAIRY	-0.788	-1.229	-0.440	-0.698	-1.669	-2.122	-0.986	-1.737	-0.589	-1.059	-1.644	-2.394
PFFV	0.860	2.086	0.331	0.823	1.433	2.797	0.876	2.379	0.236	0.660	1.084	2.400
PPFV	-0.016	-0.026	-0.208	-0.338	-1.158	-1.518	0.528	0.967	0.308	0.579	-1.227	-1.878
PALC	-0.059	-0.108	0.294	0.551	-1.182	-1.748	-0.028	-0.056	0.474	0.993	-1.140	-1.906
PNALC	0.484	0.674	-0.103	-0.147	2.239	2.512	0.281	0.445	-0.309	-0.504	2.527	3.322
PFF	0.301	0.413	-0.368	-0.512	-0.265	-0.293	0.696	1.075	-0.542	-0.858	-0.303	-0.384
PHC	0.332	0.850	0.357	0.929	-0.906	-1.871	0.116	0.336	0.498	1.479	-0.697	-1.640
MVOCCU	0.015	0.158	0.219	2.422	0.024	0.218	0.027	0.290	0.246	2.747	0.068	0.622
NOCCU							-0.105	-1.726	0.127	2.152	-0.037	-0.493
AGE	-0.016	-1.304	0.013	1.108	0.046	2.996	-0.017	-1.588	0.005	0.512	0.053	3.935
MARRIED	-0.050	-0.749	0.032	0.491	0.264	2.898	-0.050	-0.879	0.075	1.347	0.240	3.245
BLACK	-0.101	-0.804	0.030	0.246	0.026	0.159	-0.108	-1.006	-0.066	-0.634	-0.059	-0.410
HISPANIC	-0.033	-0.383	0.035	0.420	0.157	1.494	0.027	0.361	0.057	0.774	0.195	2.128
URBAN	-0.133	-1.492	-0.136	-1.543	0.286	2.411	-0.049	-0.646	-0.018	-0.243	0.328	3.150
NE	-0.384	-2.210	-0.361	-2.125	-0.161	-0.747	-0.336	-2.218	-0.294	-1.998	0.036	0.194
NC	-0.169	-0.986	-0.342	-2.030	0.131	0.588	-0.090	-0.601	-0.239	-1.644	0.250	1.291
SOUTH	-0.147	-0.787	-0.289	-1.580	0.053	0.223	-0.090	-0.551	-0.223	-1.410	0.257	1.234
Intercept	-4.135	-1.034	-3.714	-0.951	6.595	1.172	-2.880	-0.859	-1.868	-0.569	9.783	2.015
Rho21	0.372	12.430					0.376	14.415				
Rho31	-0.063	-1.550					-0.069	-1.896				
Rho32	-0.046	-1.157					-0.016	-0.443				
-Log Likelihood	3714.247						4836.450					
LRT1	136.227						181.099					
LRT2	13.83						17.27					

Table 5-3: Simulated Maximum Likelihood Estimates of the Trivariate Probit Model: Male Sample

Variable	Working Sample (N=2,056)						Overall Sample (N=2,341)					
	LP1		*LP2*		*OBESE*		*LP1*		*LP2*		*OBESE*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	0.234	3.912	0.115	1.916	-0.087	-1.158	0.231	4.105	0.145	2.572	-0.084	-1.204
EDU	-0.052	-1.057	-0.061	-1.217	-0.178	-2.679	-0.018	-0.376	-0.049	-1.052	-0.100	-1.623
V	0.069	0.840	0.008	0.094	-0.338	-2.760	0.078	0.977	0.017	0.212	-0.296	-2.571
ln(*WAGE*)	0.921	1.620	0.368	0.644	2.033	2.655	0.571	1.072	0.250	0.467	1.136	1.599
BMI25	-0.004	-0.447	0.001	0.153	0.302	22.589	-0.003	-0.445	0.000	0.039	0.290	23.676
PMF	0.705	1.329	-0.091	-0.170	-0.012	-0.018	0.403	0.806	-0.114	-0.227	0.196	0.315
PDAIRY	0.014	0.022	0.044	0.065	1.073	1.319	0.218	0.351	0.485	0.774	0.886	1.177
PFFV	-0.284	-0.644	-0.255	-0.574	-0.048	-0.087	-0.030	-0.073	-0.071	-0.172	0.030	0.058
PPFV	0.481	0.746	0.184	0.285	-0.729	-0.902	0.407	0.685	-0.051	-0.085	-0.558	-0.755
PALC	-0.219	-0.392	-0.211	-0.375	-1.010	-1.448	-0.404	-0.777	-0.241	-0.462	-0.756	-1.192
PNALC	-1.266	-1.661	-0.101	-0.132	0.810	0.869	-0.964	-1.357	-0.217	-0.303	0.226	0.260
PFF	-0.751	-0.993	-1.007	-1.326	0.469	0.493	-0.187	-0.266	-0.494	-0.699	0.727	0.827
PHC	0.145	0.362	0.368	0.920	-0.252	-0.504	-0.037	-0.099	-0.037	-0.100	-0.480	-1.029
MVOCCU	0.147	2.057	0.030	0.414	-0.144	-1.589	0.152	2.136	0.021	0.302	-0.148	-1.650
NOCCU							-0.221	-2.549	-0.130	-1.500	0.117	1.121
AGE	-0.013	-1.035	-0.001	-0.115	0.046	2.778	-0.004	-0.291	0.000	-0.007	0.047	3.039
K5	-0.073	-1.001	-0.080	-1.082	-0.058	-0.625	-0.057	-0.832	-0.076	-1.096	-0.109	-1.241
K12	0.025	0.515	-0.079	-1.577	-0.040	-0.642	0.033	0.709	-0.057	-1.196	-0.028	-0.476
K18	0.036	0.920	0.014	0.369	0.012	0.258	0.039	1.057	0.018	0.472	0.004	0.095
MARRIED	-0.310	-2.001	-0.072	-0.465	-0.118	-0.589	-0.229	-1.575	-0.057	-0.389	0.088	0.467
BLACK	0.076	0.526	-0.092	-0.628	0.852	4.377	-0.015	-0.114	-0.125	-0.925	0.658	3.690
HISPANIC	0.045	0.447	-0.305	-2.987	0.307	2.398	-0.081	-0.850	-0.323	-3.375	0.260	2.175
URBAN	-0.010	-0.157	-0.078	-1.239	-0.008	-0.103	-0.021	-0.359	-0.110	-1.863	-0.026	-0.356
NE	-0.141	-0.833	0.039	0.229	0.265	1.292	-0.160	-1.020	-0.029	-0.181	0.146	0.775
NC	-0.340	-2.249	-0.035	-0.232	0.119	0.633	-0.275	-1.939	-0.020	-0.140	0.130	0.742
SOUTH	-0.163	-0.926	-0.059	-0.329	0.197	0.905	-0.098	-0.599	-0.045	-0.275	0.172	0.849
Intercept	-4.101	-1.104	-0.860	-0.230	-23.484	-4.686	-3.025	-0.872	-0.482	-0.138	-17.561	-3.800
Rho21	0.485	17.469					0.490	18.710				
Rho31	-0.025	-0.588					-0.062	-1.590				
Rho32	0.025	0.591					-0.012	-0.315				
-Log Likelihood	3487.725						3973.143					
LRT1	230.040						267.027					
LRT2	5.68						3.92					

Table 5-4: Simulated Maximum Likelihood Estimates of the Trivariate Probit Model: Male Sample, Without Number of Children Variables

Variable	Working Sample (N=2,328)						Overall Sample (N=2,638)					
	LP1		*LP2*		*OBESE*		*LP1*		*LP2*		*OBESE*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	0.201	3.620	0.171	3.078	-0.050	-0.719	0.211	4.031	0.196	3.726	-0.048	-0.743
EDU	-0.069	-1.470	-0.045	-0.963	-0.151	-2.425	-0.039	-0.878	-0.041	-0.936	-0.090	-1.553
V	0.087	1.120	0.013	0.163	-0.322	-2.882	0.086	1.138	0.034	0.456	-0.294	-2.768
ln(*WAGE*)	1.060	1.969	0.138	0.255	1.548	2.157	0.782	1.552	0.121	0.240	0.855	1.276
BMI25	-0.004	-0.501	-0.005	-0.585	0.302	24.048	-0.003	-0.389	-0.004	-0.589	0.291	25.152
PMF	1.011	2.015	-0.012	-0.023	0.095	0.150	0.775	1.640	-0.017	-0.036	0.213	0.361
PDAIRY	-0.143	-0.228	-0.165	-0.263	1.105	1.440	0.005	0.009	0.431	0.731	0.983	1.379
PFFV	-0.206	-0.506	-0.371	-0.904	-0.527	-1.036	-0.027	-0.071	-0.137	-0.356	-0.369	-0.775
PPFV	0.309	0.512	0.054	0.090	-0.914	-1.192	0.301	0.536	-0.315	-0.560	-0.651	-0.924
PALC	-0.312	-0.600	-0.099	-0.188	-0.619	-0.953	-0.426	-0.879	-0.289	-0.593	-0.420	-0.704
PNALC	-0.947	-1.329	0.476	0.665	0.790	0.901	-0.839	-1.257	0.297	0.443	0.134	0.163
PFF	-0.276	-0.391	-0.728	-1.023	0.899	1.016	0.176	0.267	-0.224	-0.336	1.052	1.276
PHC	-0.154	-0.410	0.198	0.524	0.029	0.062	-0.232	-0.661	-0.218	-0.614	-0.217	-0.496
MVOCCU	0.153	2.316	0.037	0.563	-0.118	-1.414	0.167	2.545	0.054	0.829	-0.118	-1.431
NOCCU							-0.211	-2.561	-0.142	-1.726	0.114	1.141
AGE	-0.014	-1.163	0.001	0.098	0.047	3.092	-0.005	-0.459	0.001	0.102	0.048	3.397
MARRIED	-0.322	-2.266	-0.077	-0.537	-0.030	-0.162	-0.263	-1.969	-0.083	-0.622	0.121	0.694
BLACK	0.138	1.009	-0.114	-0.825	0.729	3.999	0.049	0.382	-0.137	-1.069	0.582	3.462
HISPANIC	0.047	0.495	-0.225	-2.351	0.208	1.752	-0.051	-0.570	-0.246	-2.751	0.179	1.613
URBAN	0.007	0.122	-0.127	-2.156	0.007	0.098	-0.004	-0.076	-0.148	-2.641	-0.019	-0.277
NE	-0.171	-1.084	0.136	0.853	0.208	1.078	-0.191	-1.305	0.045	0.304	0.101	0.568
NC	-0.279	-1.991	0.068	0.481	0.105	0.603	-0.253	-1.918	0.073	0.554	0.125	0.769
SOUTH	-0.127	-0.779	0.063	0.387	0.214	1.063	-0.085	-0.559	0.052	0.338	0.191	1.018
Intercept	-5.386	-1.534	0.147	0.042	-20.867	-4.450	-4.597	-1.400	0.066	0.020	-16.163	-3.714
Rho21	0.463	17.592					0.477	19.296				
Rho31	-0.057	-1.478					-0.039	-1.087				
Rho32	0.019	0.473					0.024	0.660				
-Log Likelihood	3970.726						4492.247					
LRT1	241.177						285.064					
LRT2	7.40						5.12					

Table 5-5: Least Squares IV Estimates of Seemingly Unrelated Regression Model I: Female Sample

Variable	Working Sample (N=2,112)						Overall Sample (N=2,750)					
	LPT1		*LPT2*		*BMIC*		*LP1*		*LPT2*		*BMIC*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	-11.011	-0.141	152.004	1.365	-0.427	-2.239	0.514	0.008	70.531	0.697	-0.299	-1.675
EDU	21.155	0.211	29.464	0.206	0.924	3.777	6.157	0.084	-7.223	-0.059	0.889	4.148
V	412.682	3.765	-123.072	-0.789	-0.946	-3.543	195.883	2.983	-87.722	-0.808	-0.658	-3.443
ln(*WAGE*)	-594.286	-0.644	-383.550	-0.292	-8.518	-3.786	-349.297	-0.518	-45.618	-0.041	-7.828	-3.987
BMI25	-4.129	-0.422	-13.887	-0.997	0.979	41.047	-3.913	-0.563	-14.656	-1.276	1.003	49.564
PMF	-599.996	-0.839	-926.628	-0.910	0.934	0.536	-669.198	-1.204	-1012.935	-1.103	1.381	0.854
PDAIRY	515.672	0.582	1023.205	0.812	-0.059	-0.027	474.407	0.686	807.282	0.706	-1.028	-0.510
PFFV	454.161	0.796	684.430	0.842	3.257	2.342	361.500	0.801	722.369	0.968	1.888	1.436
PPFV	173.636	0.202	-391.859	-0.320	-6.624	-3.160	320.427	0.481	-122.279	-0.111	-5.658	-2.919
PALC	1307.102	1.743	253.749	0.238	1.005	0.550	1169.698	1.963	153.877	0.156	0.714	0.411
PNALC	-782.263	-0.785	17.213	0.012	5.164	2.126	-732.033	-0.946	-223.680	-0.175	6.286	2.789
PFF	-991.119	-0.977	156.432	0.108	-0.711	-0.288	-631.104	-0.793	460.594	0.350	-0.810	-0.349
PHC	488.347	0.905	-139.899	-0.182	-2.123	-1.614	407.891	0.965	-527.638	-0.755	-1.403	-1.140
MVOCCU	58.253	0.453	-120.823	-0.660	-0.004	-0.014	79.393	0.701	-115.041	-0.614	0.122	0.369
NOCCU							-182.210	-2.462	30.036	0.246	0.055	0.257
AGE	-15.098	-0.865	-23.024	-0.927	0.200	4.701	-15.291	-1.127	-21.984	-0.980	0.222	5.613
K5	-128.511	-0.961	532.469	2.798	0.387	1.188	-90.621	-0.957	419.841	2.682	0.371	1.345
K12	2.335	0.036	-29.793	-0.321	0.078	0.494	-3.282	-0.066	11.064	0.134	-0.035	-0.244
K18	26.611	0.556	-9.405	-0.138	-0.095	-0.813	13.359	0.366	30.466	0.505	-0.152	-1.430
MARRIED	-265.076	-2.784	-348.761	-2.574	1.091	4.704	-159.324	-2.228	-312.363	-2.643	0.970	4.657
BLACK	-34.590	-0.201	-182.682	-0.746	0.684	1.631	-2.391	-0.019	-164.895	-0.777	0.660	1.766
HISPANIC	-1.601	-0.013	8.540	0.051	1.053	3.639	3.880	0.042	-11.481	-0.075	1.159	4.317
URBAN	-10.479	-0.085	-93.211	-0.532	0.481	1.602	-9.381	-0.101	-18.735	-0.123	0.499	1.853
NE	-191.130	-0.794	-14.263	-0.042	-0.618	-1.053	-124.302	-0.674	-169.572	-0.556	-0.336	-0.626
NC	-4.978	-0.021	478.754	1.411	1.038	1.786	2.920	0.016	332.257	1.106	0.889	1.681
SOUTH	-84.862	-0.328	161.208	0.438	0.658	1.045	-68.853	-0.348	-64.341	-0.197	0.756	1.312
Intercept	4529.589	0.826	3505.457	0.449	42.465	3.176	2833.243	0.704	2071.829	0.311	35.877	3.061
R Square	0.017		0.014		0.590		0.014		0.011		0.592	
Rho21,Rho31, Rho32	0.120, 0.009, -0.002						0.103, 0.006, -0.003					
LRT2	17.77						14.70					

Table 5-6: Least Squares IV Estimates of Seemingly Unrelated Regression Model I: Female Sample, Without Number of Children Variables

Variable	Working Sample (N=2,271)						Overall Sample (N=2,960)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-33.707	-0.440	164.130	1.571	-0.503	-2.764	-17.416	-0.291	80.675	0.852	-0.374	-2.187
EDU	33.874	0.346	22.962	0.172	0.799	3.435	19.652	0.273	-11.414	-0.100	0.825	4.018
V	331.162	3.188	-118.971	-0.841	-0.831	-3.368	163.715	2.586	-83.348	-0.832	-0.584	-3.233
ln(*WAGE*)	-644.235	-0.716	-314.794	-0.257	-7.276	-3.404	-429.616	-0.652	21.585	0.021	-7.174	-3.817
BMI25	-6.031	-0.635	-15.796	-1.222	0.976	43.293	-5.530	-0.819	-15.473	-1.450	1.000	51.946
PMF	-569.729	-0.813	-773.479	-0.810	0.518	0.311	-641.089	-1.175	-962.318	-1.116	1.204	0.774
PDAIRY	526.953	0.606	1320.998	1.116	-0.261	-0.127	462.470	0.681	1017.611	0.948	-1.350	-0.697
PFFV	410.863	0.741	538.945	0.713	3.170	2.406	362.798	0.829	599.423	0.866	1.844	1.477
PPFV	314.217	0.371	-416.623	-0.361	-6.237	-3.099	399.644	0.612	-79.667	-0.077	-5.554	-2.980
PALC	1035.092	1.412	150.355	0.150	0.627	0.360	927.914	1.597	72.617	0.079	0.086	0.052
PNALC	-754.116	-0.777	-187.196	-0.142	5.490	2.381	-690.572	-0.915	-349.809	-0.293	6.564	3.049
PFF	-876.350	-0.884	389.319	0.288	0.010	0.004	-567.030	-0.730	654.653	0.533	0.047	0.021
PHC	418.750	0.790	-86.207	-0.119	-2.384	-1.893	332.195	0.802	-429.830	-0.656	-1.399	-1.184
MVOCCU	46.641	0.370	-123.629	-0.720	0.011	0.038	61.609	0.555	-112.298	-0.640	0.124	0.393
NOCCU							-183.624	-2.550	47.023	0.413	0.088	0.428
AGE	-13.344	-0.805	-28.474	-1.261	0.182	4.617	-13.293	-1.034	-30.213	-1.486	0.212	5.771
MARRIED	-197.595	-2.173	-304.230	-2.455	0.983	4.549	-125.142	-1.829	-253.360	-2.341	0.786	4.027
BLACK	1.808	0.011	-104.694	-0.456	0.863	2.154	22.811	0.181	-109.126	-0.549	0.736	2.052
HISPANIC	-31.188	-0.269	35.909	0.227	1.010	3.668	-12.094	-0.135	23.980	0.169	1.080	4.215
URBAN	3.969	0.033	-104.047	-0.635	0.512	1.790	1.952	0.022	-40.172	-0.281	0.561	2.177
NE	-207.175	-0.888	51.622	0.162	-0.663	-1.197	-136.416	-0.761	-102.270	-0.361	-0.398	-0.778
NC	-30.016	-0.130	479.987	1.520	0.846	1.537	-6.962	-0.039	335.706	1.200	0.650	1.287
SOUTH	-98.055	-0.391	203.093	0.594	0.464	0.778	-76.230	-0.396	-19.698	-0.065	0.560	1.020
Intercept	4748.371	0.887	3064.061	0.420	36.160	2.843	3286.752	0.834	1733.103	0.278	32.588	2.897
R Square	0.013		0.010		0.593		0.011		0.007		0.593	
Rho21, Rho31, Rho32	0.116, 0.023, -0.002						0.100, 0.018, -0.003					
LRT2	18.42						15.71					

Table 5-7: Least Squares IV Estimates of Seemingly Unrelated Regression Model I: Male Sample

Variable	Working Sample (N=2,041)						Overall Sample (N=2,322)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	-120.834	-0.421	-269.893	-0.755	-0.158	-1.015	-124.779	-0.483	-183.591	-0.581	-0.231	-1.485
EDU	430.387	1.809	190.154	0.641	-0.273	-2.119	412.060	1.935	174.871	0.671	0.022	0.171
V	617.404	1.549	-362.069	-0.729	-0.437	-2.024	495.907	1.335	-326.262	-0.718	-0.403	-1.798
ln(*WAGE*)	-7070.860	-2.598	-4174.010	-1.231	2.878	1.953	-6521.284	-2.682	-3795.092	-1.276	-0.626	-0.427
BMI25	-95.175	-2.440	-65.063	-1.339	0.947	44.841	-88.934	-2.538	-65.406	-1.526	0.957	45.350
PMF	3574.725	1.397	-5438.814	-1.706	-0.493	-0.356	3192.319	1.387	-4600.263	-1.633	0.097	0.070
PDAIRY	-2407.542	-0.753	-4520.805	-1.135	4.373	2.527	-2043.778	-0.718	-3823.975	-1.097	3.761	2.192
PFFV	3199.148	1.514	3996.214	1.517	-1.106	-0.967	3160.400	1.671	3723.458	1.609	-0.611	-0.536
PPFV	2298.056	0.747	5193.645	1.355	-0.616	-0.370	1581.372	0.580	4056.199	1.216	-1.129	-0.688
PALC	-1361.926	-0.507	-5466.124	-1.635	-0.910	-0.626	-1300.124	-0.544	-4782.102	-1.636	-1.301	-0.904
PNALC	-7645.954	-2.104	2608.762	0.576	0.770	0.392	-6080.361	-1.862	1992.767	0.499	1.506	0.766
PFF	1019.416	0.280	4735.072	1.045	2.562	1.301	1473.647	0.455	3755.864	0.947	2.608	1.336
PHC	-3210.794	-1.676	-3148.358	-1.318	-0.781	-0.753	-3501.205	-2.038	-2925.684	-1.392	-1.103	-1.066
MVOCCU	421.831	1.232	-70.902	-0.166	-0.190	-1.026	474.044	1.454	-27.596	-0.069	-0.221	-1.125
NOCCU							-699.380	-1.788	-723.138	-1.511	0.501	2.127
AGE	-4.774	-0.076	-34.171	-0.439	0.120	3.534	-6.664	-0.119	-26.723	-0.389	0.136	4.028
K5	-128.753	-0.367	-223.807	-0.511	-0.095	-0.500	-181.958	-0.575	-202.632	-0.523	-0.211	-1.105
K12	214.086	0.901	205.027	0.692	-0.281	-2.183	136.471	0.628	169.855	0.638	-0.253	-1.932
K18	-25.797	-0.137	222.673	0.952	0.094	0.929	-70.578	-0.409	186.096	0.882	0.082	0.790
MARRIED	999.921	1.352	783.627	0.850	0.224	0.560	1122.340	1.692	766.210	0.944	1.077	2.696
BLACK	-1646.898	-2.364	-1313.839	-1.513	1.641	4.350	-1478.010	-2.395	-1238.855	-1.641	0.757	2.036
HISPANIC	-961.039	-1.980	-1120.755	-1.853	0.694	2.641	-896.784	-2.055	-1037.149	-1.943	0.461	1.755
URBAN	20.709	0.069	-405.084	-1.086	0.352	2.174	65.791	0.242	-339.173	-1.022	0.248	1.520
NE	-1554.535	-1.922	-519.324	-0.515	0.640	1.461	-1461.255	-2.037	-512.165	-0.584	0.612	1.417
NC	-510.927	-0.705	85.440	0.095	0.712	1.814	-407.282	-0.627	-9.054	-0.011	0.960	2.454
SOUTH	22.350	0.027	-292.064	-0.279	0.855	1.877	82.501	0.110	-324.412	-0.353	1.268	2.807
Intercept	55098.200	3.093	35258.220	1.588	-23.291	-2.415	50020.090	3.152	32843.550	1.691	-2.531	-0.265
R Square	0.024		0.013		0.548		0.022		0.012		0.536	
Rho21, Rho31, Rho32	0.344, 0.007, 0.032						0.338, 0.009, 0.026					
LRT2	10.48						10.65					

Table 5-8: Least Squares IV Estimates of Seemingly Unrelated Regression Model I: Male Sample, Without Number of Children Variables

Variable	Working Sample (N=2,311)						Overall Sample (N=2,617)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-267.144	-0.972	-221.540	-0.702	-0.065	-0.455	-237.807	-0.959	-145.345	-0.518	-0.144	-1.006
EDU	342.645	1.483	172.042	0.649	-0.237	-1.964	315.972	1.527	162.646	0.695	0.031	0.261
V	459.767	1.191	-355.277	-0.802	-0.419	-2.081	375.127	1.042	-318.424	-0.782	-0.386	-1.853
ln(*WAGE*)	-6114.800	-2.311	-3916.890	-1.290	2.159	1.565	-5505.499	-2.330	-3624.447	-1.357	-1.020	-0.747
BMI25	-94.020	-2.485	-64.516	-1.485	0.948	48.023	-85.749	-2.535	-63.701	-1.665	0.961	49.124
PMF	5151.126	2.073	-4838.022	-1.696	-0.769	-0.593	4603.701	2.061	-4148.610	-1.643	-0.378	-0.293
PDAIRY	-3755.454	-1.215	-3717.169	-1.048	3.920	2.432	-3321.817	-1.204	-3131.882	-1.004	3.663	2.297
PFFV	4402.053	2.192	3503.039	1.519	-1.176	-1.123	4220.499	2.341	3294.623	1.616	-0.784	-0.752
PPFV	787.515	0.266	5042.344	1.483	-0.801	-0.519	548.593	0.208	4084.345	1.373	-1.230	-0.809
PALC	-2328.458	-0.906	-5172.679	-1.754	-0.898	-0.670	-2074.536	-0.903	-4543.183	-1.749	-1.075	-0.810
PNALC	-5960.304	-1.703	1563.943	0.389	0.677	0.371	-4956.070	-1.574	1037.022	0.291	1.296	0.712
PFF	-1520.297	-0.435	3957.782	0.987	2.283	1.252	-903.566	-0.289	3155.270	0.892	2.216	1.226
PHC	-4120.300	-2.221	-2800.461	-1.315	-0.546	-0.564	-4284.592	-2.575	-2618.101	-1.391	-0.711	-0.739
MVOCCU	818.341	2.513	55.273	0.148	-0.196	-1.153	869.442	2.807	93.102	0.266	-0.213	-1.191
NOCCU							-651.331	-1.702	-677.551	-1.566	0.504	2.279
AGE	-63.243	-1.070	-31.484	-0.464	0.130	4.225	-54.084	-1.014	-23.636	-0.392	0.147	4.765
MARRIED	988.688	1.416	906.465	1.131	0.335	0.921	978.445	1.566	867.639	1.228	1.088	3.013
BLACK	-1544.850	-2.286	-1284.435	-1.656	1.535	4.356	-1362.309	-2.270	-1229.551	-1.812	0.745	2.147
HISPANIC	-1089.865	-2.338	-1030.904	-1.926	0.592	2.435	-989.476	-2.367	-966.391	-2.044	0.356	1.472
URBAN	350.156	1.203	-398.756	-1.194	0.255	1.678	352.982	1.337	-341.785	-1.145	0.156	1.019
NE	-1828.465	-2.354	-455.987	-0.511	0.548	1.352	-1711.386	-2.475	-455.639	-0.583	0.546	1.366
NC	-792.066	-1.144	114.351	0.144	0.533	1.476	-675.324	-1.087	34.120	0.049	0.822	2.287
SOUTH	-111.901	-0.140	-216.515	-0.236	0.676	1.621	-69.680	-0.098	-252.053	-0.312	1.105	2.674
Intercept	54489.350	3.153	33816.240	1.705	-17.667	-1.960	48416.700	3.140	31767.400	1.822	0.691	0.078
R Square	0.030		0.012		0.550		0.029		0.012		0.545	
Rho21, Rho31, Rho32	0.313, -0.005, 0.030						0.308, -0.001, 0.025					
LRT2	9.45						9.43					

Table 5-9: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Female Sample, Working Sample

Variable	Overweight (BMI25>=25, N=650)						Non-overweight (BMI25<25, N=1,462)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-74.112	-0.602	63.839	0.535	-0.437	-0.808	4.563	0.046	207.228	1.364	0.028	0.129
EDU	167.770	1.012	-46.227	-0.288	-0.782	-1.075	2.138	0.018	-0.769	-0.004	3.783	14.259
V	162.150	0.574	-219.954	-0.802	-3.579	-2.885	457.324	3.720	-98.043	-0.518	-0.871	-3.253
ln(*WAGE*)	-1717.761	-1.137	418.019	0.285	9.041	1.362	-544.300	-0.485	-131.572	-0.076	-36.379	-14.882
PMF	-1911.122	-1.681	-580.063	-0.526	-3.720	-0.745	-235.445	-0.262	-890.754	-0.644	2.170	1.108
PDAIRY	-2610.596	-1.913	2371.134	1.791	5.207	0.869	1699.193	1.508	93.117	0.054	-1.189	-0.484
PFFV	1729.232	1.911	692.849	0.789	-0.588	-0.148	-117.667	-0.164	742.953	0.674	3.554	2.279
PPFV	-1279.017	-0.983	-2330.337	-1.846	-2.178	-0.381	1050.029	0.950	696.478	0.409	-7.026	-2.917
PALC	1554.782	1.311	1056.861	0.919	0.616	0.118	1019.006	1.080	-7.704	-0.005	2.398	1.166
PNALC	4122.896	2.619	1073.207	0.703	-2.423	-0.350	-2661.755	-2.123	-452.986	-0.235	6.258	2.291
PFF	1426.441	0.911	-1509.015	-0.993	-0.041	-0.006	-2243.733	-1.742	940.586	0.474	-2.189	-0.780
PHC	1349.621	1.593	1380.074	1.678	4.729	1.271	234.829	0.345	-956.326	-0.912	-2.309	-1.555
MVOCCU	-186.963	-0.934	-6.185	-0.032	-0.088	-0.100	163.393	1.003	-155.222	-0.619	0.091	0.257
NOCCU												
AGE	16.241	0.563	-41.094	-1.468	0.301	2.378	-30.669	-1.426	-14.613	-0.441	0.033	0.708
K5	-95.412	-0.378	-133.572	-0.545	1.185	1.069	-139.667	-0.879	750.313	3.068	0.276	0.796
K12	38.235	0.351	12.745	0.121	0.061	0.127	4.871	0.061	-41.541	-0.336	-0.002	-0.009
K18	39.487	0.521	-26.650	-0.363	-0.443	-1.332	21.343	0.355	0.214	0.002	0.145	1.104
MARRIED	-184.775	-1.142	-186.820	-1.190	1.411	1.986	-266.199	-2.224	-425.142	-2.307	0.731	2.803
BLACK	-209.360	-0.781	48.036	0.185	4.281	3.635	-35.126	-0.162	-250.661	-0.752	-3.588	-7.606
HISPANIC	-105.982	-0.552	-25.117	-0.135	0.724	0.859	43.255	0.292	-23.361	-0.102	1.872	5.793
URBAN	36.766	0.182	-247.501	-1.263	-1.827	-2.060	1.556	0.010	-67.561	-0.288	3.088	9.296
NE	-330.381	-0.892	174.156	0.485	-1.497	-0.920	11.702	0.038	-219.120	-0.467	2.115	3.183
NC	8.820	0.023	574.136	1.531	-1.403	-0.826	61.352	0.208	336.236	0.739	5.006	7.773
SOUTH	26.109	0.061	411.708	0.999	-1.117	-0.599	-19.563	-0.062	-21.542	-0.044	4.804	6.967
Intercept	5297.932	0.613	-2385.655	-0.285	-32.718	-0.862	6724.671	1.023	2093.455	0.207	226.129	15.794
R Square	0.052		0.047		0.084		0.026		0.016		0.200	
Rho21, Rho31, Rho32	0.136, -0.011, -0.028						0.120, 0.029, -0.020					
LRT2	2.89						20.84					

Table 5-10: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Female Sample, Overall Sample

Variable	Overweight (BMI25>=25, N=882)						Non-overweight (BMI25<25, N=1,868)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-40.856	-0.445	50.186	0.520	0.146	0.287	13.182	0.167	85.371	0.602	-0.013	-0.067
EDU	133.491	1.189	-2.330	-0.020	-1.411	-2.266	-13.116	-0.137	-26.562	-0.155	3.805	16.001
V	65.392	0.404	-21.238	-0.125	-2.068	-2.305	218.473	2.911	-93.894	-0.696	-0.520	-2.787
ln(*WAGE*)	-1331.754	-1.303	41.458	0.039	15.397	2.718	-288.440	-0.327	63.686	0.040	-36.318	-16.572
PMF	-1472.048	-1.740	230.396	0.259	-1.347	-0.287	-420.608	-0.590	-1385.709	-1.081	2.407	1.357
PDAIRY	-1762.194	-1.719	2254.698	2.092	-0.347	-0.061	1449.388	1.619	-123.108	-0.077	-1.355	-0.609
PFFV	1353.944	1.975	178.469	0.248	-1.603	-0.422	-90.402	-0.157	1064.484	1.026	2.517	1.753
PPFV	-805.507	-0.799	-2439.455	-2.302	-2.652	-0.475	960.234	1.123	943.304	0.614	-6.130	-2.883
PALC	1151.527	1.286	1049.915	1.115	-1.557	-0.314	978.068	1.271	-278.673	-0.202	2.742	1.433
PNALC	2667.326	2.286	393.455	0.321	1.046	0.162	-2147.540	-2.158	-594.829	-0.333	6.305	2.548
PFF	916.585	0.759	-1722.512	-1.357	-2.840	-0.424	-1370.873	-1.339	1525.754	0.830	-1.646	-0.647
PHC	934.477	1.461	870.264	1.294	4.248	1.198	198.187	0.366	-1318.782	-1.355	-1.571	-1.167
MVOCCU	-173.317	-1.010	9.021	0.050	0.053	0.056	189.934	1.307	-161.795	-0.619	0.202	0.559
NOCCU	-179.626	-1.652	-60.073	-0.525	1.915	3.177	-185.707	-1.922	95.743	0.552	-0.011	-0.044
AGE	10.384	0.490	-37.682	-1.692	0.363	3.092	-27.975	-1.629	-16.540	-0.536	0.048	1.131
K5	-66.928	-0.405	29.328	0.169	0.076	0.083	-101.065	-0.875	568.479	2.739	0.455	1.585
K12	21.618	0.269	-36.375	-0.430	-0.091	-0.204	-1.302	-0.021	48.967	0.438	-0.106	-0.684
K18	16.248	0.295	-64.587	-1.115	-0.629	-2.059	12.842	0.273	79.854	0.943	0.130	1.106
MARRIED	-112.189	-1.007	-158.457	-1.353	0.686	1.112	-154.991	-1.672	-409.749	-2.460	0.710	3.081
BLACK	-169.593	-0.911	23.592	0.121	5.352	5.187	9.908	0.058	-270.771	-0.883	-3.793	-8.934
HISPANIC	-60.856	-0.427	77.979	0.521	0.842	1.067	37.970	0.322	-77.240	-0.365	1.995	6.803
URBAN	52.192	0.374	-118.416	-0.806	-2.306	-2.978	6.389	0.053	30.787	0.142	3.253	10.817
NE	-232.790	-0.859	-39.754	-0.139	-1.985	-1.321	37.036	0.154	-323.591	-0.749	2.090	3.493
NC	51.102	0.181	252.507	0.849	-3.433	-2.191	60.371	0.260	299.610	0.717	5.077	8.777
SOUTH	31.464	0.102	112.382	0.345	-3.190	-1.858	-8.688	-0.034	-214.031	-0.473	5.052	8.064
Intercept	4596.339	0.779	1007.830	0.162	-63.822	-1.951	4168.874	0.806	1508.497	0.162	222.821	17.311
R Square	0.038		0.031		0.078		0.020		0.015		0.183	
Rho21, Rho31, Rho32	0.138, -0.003, -0.013						0.100, 0.021, -0.023					
LRT2	3.60						21.28					

Table 5-11: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Female Sample, No Number of Children Variables, Working Sample

Variable	Overweight (BMI25>=25, N=715)						Non-overweight (BMI25<25, N=1,556)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-78.772	-0.705	104.281	0.932	-0.757	-1.495	-21.086	-0.213	191.334	1.332	-0.001	-0.007
EDU	114.278	0.756	-97.693	-0.646	-1.118	-1.633	53.582	0.438	-3.506	-0.020	3.683	14.481
V	176.720	0.697	-183.943	-0.725	-3.390	-2.951	365.342	3.078	-98.004	-0.570	-0.747	-3.027
ln(*WAGE*)	-1172.184	-0.849	820.393	0.594	12.672	2.025	-940.076	-0.836	-54.971	-0.034	-35.456	-15.165
PMF	-1431.098	-1.401	-795.667	-0.778	-3.077	-0.665	-274.869	-0.303	-654.460	-0.498	1.973	1.046
PDAIRY	-2047.283	-1.653	3166.469	2.554	4.251	0.758	1742.077	1.533	150.231	0.091	-1.395	-0.591
PFFV	1286.552	1.621	251.040	0.316	-0.057	-0.016	-73.719	-0.102	732.081	0.699	3.378	2.246
PPFV	-928.777	-0.777	-1921.245	-1.607	-4.254	-0.786	1225.847	1.097	538.300	0.332	-7.034	-3.027
PALC	991.982	0.933	753.968	0.708	1.134	0.235	749.497	0.785	-193.571	-0.140	2.623	1.323
PNALC	3000.832	2.176	258.162	0.187	2.144	0.343	-2674.270	-2.106	-448.145	-0.244	6.398	2.423
PFF	876.289	0.616	-1254.947	-0.882	0.158	0.025	-1933.971	-1.494	1011.022	0.539	-1.836	-0.682
PHC	974.418	1.258	1441.257	1.859	2.667	0.760	140.754	0.205	-909.847	-0.915	-2.224	-1.559
MVOCCU	-158.473	-0.881	-22.747	-0.126	0.093	0.115	140.018	0.852	-172.948	-0.726	0.022	0.063
NOCCU												
AGE	18.003	0.714	-22.772	-0.903	0.292	2.555	-28.750	-1.369	-28.118	-0.924	0.017	0.385
MARRIED	-169.461	-1.168	-234.822	-1.617	1.258	1.915	-172.665	-1.473	-337.669	-1.988	0.731	2.998
BLACK	-112.386	-0.460	165.029	0.675	4.490	4.054	-18.138	-0.083	-151.023	-0.477	-3.337	-7.352
HISPANIC	-91.853	-0.527	-34.645	-0.199	0.343	0.434	16.226	0.109	22.628	0.105	1.837	5.941
URBAN	56.596	0.307	-311.189	-1.689	-1.904	-2.282	40.826	0.267	-71.762	-0.324	3.065	9.640
NE	-244.529	-0.738	424.356	1.279	-2.141	-1.425	-24.191	-0.079	-232.461	-0.524	1.953	3.066
NC	-44.959	-0.129	581.969	1.670	-1.962	-1.244	70.493	0.239	285.823	0.668	4.826	7.860
SOUTH	-15.829	-0.042	421.086	1.112	-1.664	-0.971	-15.798	-0.050	-35.768	-0.078	4.557	6.889
Intercept	3704.488	0.468	-5135.935	-0.648	-54.325	-1.515	8594.097	1.301	2101.103	0.220	221.633	16.147
R Square	0.038		0.048		0.078		0.020		0.009		0.201	
Rho21, Rho31, Rho32	0.138, -0.001, -0.032						0.114, 0.041, -0.020					
LRT2	2.51						21.74					

Table 5-12: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Female Sample, No Number of Children Variables, Overall Sample

Variable	Overweight (BMI25>=25, N=970)						Non-overweight (BMI25<25, N=1,990)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-39.266	-0.470	80.614	0.886	-0.228	-0.475	-10.821	-0.137	76.221	0.570	-0.019	-0.103
EDU	98.021	0.953	-22.320	-0.199	-1.653	-2.804	32.051	0.334	-44.221	-0.272	3.734	16.280
V	57.403	0.424	-64.702	-0.439	-1.234	-1.591	186.877	2.505	-78.806	-0.625	-0.460	-2.580
ln(*WAGE*)	-981.397	-1.046	181.800	0.178	17.734	3.299	-653.021	-0.740	309.904	0.208	-35.640	-16.912
PMF	-1175.562	-1.536	-5.821	-0.007	0.024	0.005	-449.263	-0.624	-1274.810	-1.047	1.875	1.090
PDAIRY	-1524.206	-1.630	2782.050	2.733	-0.416	-0.078	1480.874	1.641	-49.073	-0.032	-1.932	-0.896
PFFV	1135.923	1.872	-90.859	-0.138	-1.149	-0.330	-34.743	-0.060	1064.684	1.085	2.505	1.807
PPFV	-620.351	-0.677	-2091.024	-2.095	-5.033	-0.958	1060.123	1.228	956.162	0.655	-5.923	-2.872
PALC	749.173	0.931	902.316	1.030	-0.789	-0.171	751.966	0.971	-444.458	-0.339	2.455	1.327
PNALC	2126.834	2.055	-61.869	-0.055	3.481	0.587	-2125.647	-2.113	-604.315	-0.355	6.778	2.820
PFF	584.307	0.536	-1247.929	-1.052	-1.724	-0.276	-1193.172	-1.163	1550.596	0.893	-1.475	-0.602
PHC	692.458	1.183	925.255	1.452	2.982	0.889	110.327	0.203	-1242.418	-1.351	-1.155	-0.890
MVOCCU	-151.455	-0.979	2.044	0.012	0.176	0.199	160.369	1.095	-173.709	-0.702	0.128	0.367
NOCCU	-162.905	-1.658	-62.244	-0.582	1.829	3.249	-194.210	-2.012	100.319	0.615	-0.113	-0.492
AGE	10.481	0.566	-26.022	-1.291	0.390	3.673	-25.662	-1.536	-31.664	-1.121	0.035	0.881
MARRIED	-106.087	-1.090	-174.029	-1.642	-0.002	-0.004	-101.217	-1.110	-304.896	-1.977	0.690	3.166
BLACK	-111.375	-0.655	62.526	0.338	5.404	5.545	20.504	0.119	-169.902	-0.585	-3.585	-8.739
HISPANIC	-59.401	-0.462	69.549	0.497	0.465	0.631	25.468	0.216	-35.218	-0.177	1.952	6.929
URBAN	59.375	0.465	-161.711	-1.164	-2.376	-3.247	32.905	0.272	-0.229	-0.001	3.205	11.079
NE	-182.496	-0.747	173.106	0.651	-2.657	-1.897	13.746	0.057	-332.418	-0.815	2.003	3.476
NC	5.964	0.023	317.892	1.147	-3.910	-2.679	82.749	0.355	249.503	0.633	4.865	8.744
SOUTH	2.925	0.011	212.938	0.704	-3.638	-2.283	2.650	0.010	-238.727	-0.559	4.796	7.947
Intercept	3584.232	0.660	-633.575	-0.107	-80.262	-2.579	5994.897	1.153	579.902	0.066	219.918	17.708
R Square	0.030		0.030		0.069		0.016		0.009		0.181	
Rho21, Rho31, Rho32	0.136, 0.005, -0.017						0.096, 0.032, -0.022					
LRT2	3.04						20.98					

Table 5-13: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Male Sample, Working Sample

Variable	Overweight (BMI25>=25, N=892)						Non-overweight (BMI25<25, N=1,149)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value	Coeff.	Z-Value
RNI	-261.105	-1.221	-319.712	-0.523	-0.186	-0.598	33.314	0.068	-285.288	-0.682	0.091	0.455
EDU	-131.276	-0.872	50.191	0.117	2.258	10.296	772.976	1.773	31.088	0.083	-0.493	-2.775
V	-269.379	-0.861	-747.638	-0.836	-0.551	-1.208	1195.474	1.820	-204.345	-0.363	-0.326	-1.218
ln(*WAGE*)	178.158	0.106	-2010.071	-0.418	-27.535	-11.225	-11487.260	-2.294	-2388.917	-0.557	5.381	2.638
PMF	2107.401	1.078	-8448.823	-1.512	-1.460	-0.512	4256.923	0.997	-3769.406	-1.031	-1.568	-0.902
PDAIRY	359.415	0.150	-2670.191	-0.390	6.998	2.007	-5340.385	-0.973	-7086.571	-1.509	2.861	1.280
PFFV	187.447	0.117	5748.243	1.260	-1.193	-0.513	6696.747	1.867	4186.320	1.364	-1.113	-0.762
PPFV	2481.732	1.051	2451.795	0.363	1.689	0.491	2610.544	0.508	7164.019	1.628	-1.335	-0.638
PALC	642.898	0.320	-2605.669	-0.454	-3.898	-1.332	-3528.638	-0.773	-8407.844	-2.153	-0.577	-0.310
PNALC	-7131.948	-2.690	1392.361	0.184	-4.848	-1.255	-8332.965	-1.321	4261.252	0.789	3.751	1.460
PFF	-6421.234	-2.315	3118.367	0.393	6.903	1.708	6302.342	1.037	5761.424	1.107	2.671	1.079
PHC	1270.859	0.865	-4896.501	-1.166	-3.170	-1.480	-7075.032	-2.219	-2334.921	-0.856	1.063	0.819
MVOCCU	13.951	0.053	-510.189	-0.683	-0.503	-1.320	780.708	1.367	336.654	0.688	-0.016	-0.069
NOCCU												
AGE	31.206	0.652	-19.145	-0.140	0.266	3.808	-18.270	-0.174	-47.187	-0.525	0.067	1.565
K5	88.845	0.343	-307.672	-0.416	0.091	0.242	-361.460	-0.597	-184.496	-0.356	-0.421	-1.709
K12	49.482	0.273	511.190	0.986	-0.250	-0.946	376.963	0.949	-29.266	-0.086	-0.309	-1.912
K18	32.918	0.240	596.228	1.522	0.408	2.041	-165.619	-0.507	-57.939	-0.207	0.005	0.039
MARRIED	-158.480	-0.329	647.018	0.470	7.420	10.583	1675.241	1.261	63.817	0.056	-0.086	-0.159
BLACK	581.467	1.249	-705.554	-0.530	-4.761	-7.019	-3192.475	-2.568	-1093.905	-1.028	2.154	4.253
HISPANIC	87.225	0.251	-532.655	-0.536	-1.504	-2.970	-1899.319	-2.199	-1358.363	-1.837	1.334	3.792
URBAN	-166.295	-0.746	-820.389	-1.288	-0.416	-1.281	197.824	0.389	56.108	0.129	0.362	1.746
NE	-372.194	-0.631	-702.453	-0.417	1.454	1.691	-2659.711	-1.893	-693.222	-0.577	0.775	1.355
NC	-403.586	-0.725	313.385	0.197	3.224	3.977	-834.030	-0.681	-369.046	-0.352	0.403	0.809
SOUTH	-251.183	-0.407	-1843.819	-1.047	4.049	4.508	-148.738	-0.102	303.422	0.243	0.500	0.843
Intercept	6814.742	0.617	23466.920	0.743	188.518	11.706	81783.210	2.580	21079.370	0.777	-17.290	-1.339
R Square	0.044		0.019		0.173		0.033		0.025		0.070	
Rho21, Rho31, Rho32	0.028, -0.060, -0.013						0.555, 0.010, 0.007					
LRT2	9.32						7.26					

Table 5-14: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Male Sample, Overall Working

Variable	Overweight (BMI25>=25, N=1,017)						Non-overweight (BMI25<25, N=1,305)					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	-188.415	-0.994	-272.196	-0.507	-0.153	-0.495	-39.641	-0.090	-166.163	-0.447	0.031	0.156
EDU	-87.151	-0.667	-1.218	-0.003	2.780	13.036	708.223	1.796	36.599	0.110	-0.345	-1.940
V	-280.451	-0.981	-682.987	-0.843	-0.538	-1.153	1033.943	1.681	-161.134	-0.311	-0.276	-0.994
ln(*WAGE*)	-131.474	-0.090	-1379.657	-0.335	-33.801	-14.242	-10256.170	-2.267	-2242.947	-0.588	3.724	1.825
PMF	1454.937	0.840	-7368.065	-1.501	0.071	0.025	4169.601	1.082	-2988.052	-0.920	-0.906	-0.521
PDAIRY	578.152	0.276	-2131.507	-0.359	4.591	1.343	-4460.677	-0.910	-5918.940	-1.433	3.315	1.500
PFFV	630.403	0.445	4814.800	1.199	-0.786	-0.340	5984.759	1.873	4168.832	1.548	-0.868	-0.602
PPFV	2226.410	1.074	1744.978	0.297	1.408	0.416	1368.723	0.301	5736.423	1.496	-1.922	-0.937
PALC	176.297	0.100	-1884.828	-0.376	-5.785	-2.004	-2871.679	-0.704	-7686.947	-2.236	0.345	0.188
PNALC	-6391.398	-2.699	1308.902	0.195	-3.014	-0.780	-6035.580	-1.068	3074.378	0.645	3.113	1.221
PFF	-5984.891	-2.445	2107.308	0.304	6.822	1.708	6594.508	1.221	4808.026	1.056	3.608	1.481
PHC	842.400	0.644	-4096.328	-1.105	-3.768	-1.764	-7106.924	-2.494	-2518.479	-1.049	0.406	0.316
MVOCCU	57.231	0.233	-505.759	-0.726	-0.569	-1.416	836.378	1.536	396.244	0.863	0.005	0.019
NOCCU	-627.311	-2.137	-729.716	-0.877	-0.042	-0.088	-620.481	-0.948	-603.843	-1.095	0.422	1.432
AGE	23.467	0.553	-24.246	-0.202	0.302	4.365	-25.298	-0.267	-36.078	-0.452	0.074	1.745
K5	25.166	0.110	-277.299	-0.428	-0.107	-0.286	-413.706	-0.751	-174.955	-0.377	-0.433	-1.743
K12	46.470	0.280	534.016	1.135	-0.306	-1.131	232.054	0.643	-64.354	-0.212	-0.224	-1.379
K18	28.948	0.232	540.377	1.532	0.386	1.900	-227.140	-0.759	-96.565	-0.383	0.003	0.026
MARRIED	-48.065	-0.115	395.507	0.334	8.976	13.174	1779.568	1.475	203.323	0.200	0.350	0.644
BLACK	370.915	0.926	-581.547	-0.512	-6.201	-9.486	-2699.702	-2.426	-1045.774	-1.115	1.624	3.237
HISPANIC	-27.180	-0.088	-491.482	-0.561	-1.932	-3.831	-1635.145	-2.110	-1218.858	-1.866	1.278	3.657
URBAN	-136.610	-0.676	-742.130	-1.297	-0.481	-1.460	242.248	0.531	91.924	0.239	0.221	1.073
NE	-397.584	-0.769	-556.418	-0.380	1.646	1.951	-2387.866	-1.909	-707.171	-0.671	0.437	0.775
NC	-300.731	-0.611	246.306	0.177	3.476	4.328	-640.444	-0.582	-411.295	-0.443	0.458	0.923
SOUTH	-257.771	-0.474	-1697.405	-1.102	4.882	5.503	42.095	0.032	214.118	0.195	0.503	0.857
Intercept	8774.903	0.918	19239.050	0.710	227.198	14.558	71448.480	2.508	20437.110	0.851	-8.566	-0.667
R Square	0.040		0.018		0.214		0.030		0.022		0.057	
Rho21, Rho31, Rho32	0.027, -0.051, -0.012						0.540, 0.012, 0.004					
LRT2	9.39						7.77					

Table 5-15: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Male Sample, No Number of Children Variables, Working Sample

Variable	*Overweight (BMI25>=25, N=1,023)*						*Non-overweight (BMI25<25, N=1,288)*					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	-371.422	-1.775	-360.054	-0.682	-0.115	-0.407	-141.310	-0.300	-161.221	-0.429	0.169	0.905
EDU	-138.991	-0.920	59.569	0.156	2.234	10.989	616.329	1.453	35.697	0.106	-0.527	-3.129
V	-298.476	-0.975	-730.273	-0.945	-0.645	-1.564	961.890	1.493	-175.892	-0.342	-0.227	-0.888
ln(*WAGE*)	115.402	0.068	-1912.804	-0.447	-27.619	-12.094	-9711.157	-1.994	-2613.566	-0.673	5.538	2.865
PMF	2451.708	1.249	-7370.117	-1.487	-0.153	-0.058	6554.618	1.580	-3472.385	-1.049	-2.008	-1.219
PDAIRY	-581.027	-0.242	-1338.531	-0.221	7.276	2.253	-6648.711	-1.263	-6078.885	-1.448	2.807	1.344
PFFV	1182.426	0.744	4637.795	1.157	-1.562	-0.731	7721.747	2.303	3701.898	1.385	-1.561	-1.173
PPFV	2399.553	1.010	1749.136	0.292	-0.942	-0.295	-193.054	-0.039	7490.300	1.916	-0.273	-0.140
PALC	-551.642	-0.277	-2782.197	-0.553	-4.033	-1.504	-4322.952	-0.992	-7690.060	-2.213	-0.586	-0.339
PNALC	-6966.078	-2.640	865.331	0.130	-2.857	-0.805	-4966.183	-0.820	2155.640	0.446	1.765	0.734
PFF	-2920.835	-1.075	2629.357	0.384	4.690	1.283	-696.249	-0.118	4783.504	1.015	2.659	1.133
PHC	-424.845	-0.293	-4014.659	-1.095	-2.301	-1.177	-7246.081	-2.325	-2142.132	-0.862	0.587	0.475
MVOCCU	265.318	1.040	-410.981	-0.638	-0.473	-1.378	1196.636	2.192	439.353	1.009	-0.051	-0.233
NOCCU												
AGE	-12.500	-0.268	-19.258	-0.164	0.244	3.884	-103.635	-1.045	-47.131	-0.596	0.111	2.809
MARRIED	-112.885	-0.243	1020.158	0.871	7.734	12.391	1548.195	1.229	114.707	0.114	-0.440	-0.880
BLACK	330.600	0.711	-653.145	-0.557	-4.729	-7.559	-2851.026	-2.355	-1240.976	-1.285	2.221	4.623
HISPANIC	-11.273	-0.033	-378.210	-0.440	-1.602	-3.499	-2052.505	-2.456	-1380.619	-2.071	1.343	4.050
URBAN	46.910	0.213	-738.330	-1.329	-0.382	-1.290	637.760	1.275	-9.113	-0.023	0.204	1.026
NE	-797.870	-1.348	-456.871	-0.306	1.412	1.773	-2663.894	-1.997	-740.112	-0.696	0.602	1.137
NC	-481.960	-0.879	490.090	0.354	3.227	4.376	-1225.585	-1.053	-416.145	-0.448	0.056	0.121
SOUTH	-247.085	-0.400	-1485.166	-0.954	4.073	4.906	-218.019	-0.161	266.927	0.247	0.082	0.152
Intercept	8214.627	0.742	22108.530	0.791	191.234	12.835	79664.620	2.580	23731.410	0.964	-17.080	-1.394
R Square	0.040		0.014		0.173		0.037		0.025		0.060	
Rho21, Rho31, Rho32	0.024, -0.073, -0.009						0.501, 0.006, 0.010					
LRT2	9.68						7.03					

Table 5-16: Least Squares IV Estimates of Seemingly Unrelated Regression Model II: Male Sample, No Number of Children Variables, Overall Sample

Variable	*Overweight (BMI25>=25, N=1,158)*						*Non-overweight (BMI25<25, N=1,459)*					
	LPT1		*LPT2*		*BMIC*		*LPT1*		*LPT2*		*BMIC*	
	Coeff.	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**	**Coeff.**	**Z-Value**
RNI	-280.288	-1.501	-301.195	-0.644	-0.051	-0.182	-177.561	-0.417	-76.020	-0.227	0.105	0.563
EDU	-115.146	-0.878	29.410	0.089	2.777	14.033	550.983	1.435	44.924	0.149	-0.391	-2.328
V	-304.819	-1.084	-663.449	-0.941	-0.633	-1.492	846.483	1.403	-144.005	-0.303	-0.192	-0.727
ln(*WAGE*)	39.956	0.027	-1509.540	-0.412	-34.138	-15.464	-8560.258	-1.945	-2506.255	-0.722	4.010	2.083
PMF	1892.793	1.088	-6454.795	-1.480	1.437	0.547	6215.401	1.662	-2897.327	-0.983	-1.568	-0.959
PDAIRY	-430.600	-0.204	-1012.736	-0.191	5.460	1.715	-5718.111	-1.215	-5087.392	-1.372	3.263	1.586
PFFV	1382.874	0.975	3957.394	1.113	-1.010	-0.472	6987.416	2.329	3732.799	1.579	-1.395	-1.063
PPFV	2223.599	1.066	1200.245	0.229	-1.142	-0.363	-569.961	-0.131	6238.033	1.816	-0.696	-0.365
PALC	-727.351	-0.413	-2104.217	-0.476	-4.892	-1.840	-3639.110	-0.930	-7089.651	-2.298	0.380	0.222
PNALC	-6312.924	-2.676	812.047	0.137	-2.077	-0.583	-3729.055	-0.685	1290.198	0.301	1.323	0.556
PFF	-2945.722	-1.219	2004.074	0.331	3.796	1.041	507.423	0.096	3989.853	0.962	3.485	1.515
PHC	-600.438	-0.463	-3446.098	-1.059	-2.649	-1.352	-7321.726	-2.630	-2267.115	-1.033	0.235	0.193
MVOCCU	307.659	1.279	-403.877	-0.670	-0.516	-1.421	1255.080	2.417	497.079	1.215	-0.025	-0.109
NOCCU	-606.567	-2.041	-704.935	-0.946	0.317	0.706	-634.715	-0.990	-585.040	-1.159	0.370	1.320
AGE	-12.882	-0.310	-24.806	-0.238	0.296	4.713	-92.198	-1.030	-34.164	-0.484	0.108	2.761
MARRIED	-75.426	-0.189	822.242	0.821	9.282	15.404	1495.198	1.306	214.252	0.238	0.006	0.012
BLACK	202.591	0.505	-582.534	-0.579	-6.133	-10.124	-2389.548	-2.201	-1196.557	-1.399	1.712	3.606
HISPANIC	-76.359	-0.253	-358.926	-0.474	-1.996	-4.376	-1772.694	-2.368	-1272.601	-2.157	1.260	3.848
URBAN	65.994	0.330	-679.388	-1.354	-0.543	-1.797	604.149	1.346	29.461	0.083	0.107	0.544
NE	-777.550	-1.493	-360.215	-0.276	1.416	1.802	-2404.212	-2.015	-724.874	-0.771	0.357	0.684
NC	-419.632	-0.866	428.837	0.353	3.568	4.880	-988.580	-0.942	-436.597	-0.528	0.140	0.306
SOUTH	-283.713	-0.521	-1362.625	-0.998	4.820	5.865	-46.923	-0.039	196.969	0.205	0.175	0.329
Intercept	8551.788	0.893	19124.030	0.796	230.560	15.947	68699.640	2.474	22972.300	1.050	-9.103	-0.750
R Square	0.038		0.013		0.219		0.034		0.023		0.050	
Rho21, Rho31, Rho32	0.024, -0.064, -0.009						0.490, 0.010, 0.006					
LRT2	8.50						6.87					

APPENDIX I. MET OF SELECTED PHYSICAL ACTIVITIES

Table A1: Metabolic expenditure values used for calculating intensity of leisure-time physical activity, by activity—Behavioral Risk Factor Surveillance System, United States, 1990-1998[28]

Activity	Metabolic Expenditure	Activity	Metabolic Expenditure
Aerobics class	6.5	Painting, papering	3.0
Backpacking	7.0	Racquetball	7.0
Badminton	4.5	Raking lawn	4.3
Basketball	6.0	Rope skipping	10.0
Bicycle machine	7.0	Rowing machine	7.0
Biking (pleasure)	6.0	Running	8.0
Boating (pleasure)	2.5	Scuba diving	7.0
Bowling	3.0	Skating(any)	7.0
Boxing	9.0	Sledding	7.0
Calisthenics	3.5	Snorkeling	5.0
Canoeing (competitive)	3.5	Snow blowing	4.5
Carpentry	3.0	Snow shoeing	8.0
Dancing	4.5	Snow shoveling	6.0
Fishing (bank or boat)	3.5	Snow skiing	7.0
Gardening	4.0	Soccer	7.0
Golf	4.5	Softball	5.0
Handball	10.0	Squash	12.0
Health club exercise	5.5	Stair climbing	8.0
Hiking	6.0	Stream fishing	6.0
Home exercise	5.5	Surfing	3.0
Horseback riding	4.0	Swimming laps	6.0
Hunting	5.0	Table tennis	4.0
Jogging	7.0	Tennis	7.0
Judo, Karate	10.0	Touch football	8.0
Mountain climbing	8.0	Volleyball	4.0
Mowing lawn	5.5	Walking	3.5
Other	4.5	Water skiing	6.0
Paddleball	6.0	Weightlifting	3.0

[28] Source: Physical Activity Trends — United States, 1990—1998. Morbidity and Mortality Weekly Reports (MMWR), March 09, 2001 / 50(09);166-9

Table A2: Estimated MET levels for selected physical activities in the compendium of physical activity[29]

METs	CATEGORY	SPECIFIC ACTIITIES
0.9	Inactivity	Sleeping
1.0	Inactivity	Sitting quietly and watching television
2.0	Transportation	Driving an automobile or light truck (not a semi)
3.0	Walking	Walking very slowly,strolling, household walking
4.0	Lawn and Garden	Raking the lawn, general gardening
5.0	Home Repair	Cleaning gutters, painting outside of home
6.0	Occupation	Using heavy power tools (jackhammer)
7.0	Conditioning	Stationary bicycle, ski or rowing machine
8.0	Sports	Competitive basketball game, touch football
9.0	Walking	Climbing hills with a 42 lb. backpack
10.0	Water	Freestyle lap swimming, vigorous effort
11.0	Running	Running at 9 minutes/mile
12.0	Bicycling	Road cycling 14-16 mph, fast or general racing
13.0/14.0	Running	Running at 7-7.5 minutes/mile
15.0	Winter	Competitive speed skating

[29] Source: Ainsworth, B. E. 2003. The Compendium of Physical Activities. Presidents Council on Physical Fitness and Sports Research Digest, Series 4, No. 2

APPENDIX II. SELECTED SURVEY QUESTIONS

Physical Activity Survey Questions

1. Vigorous Activity

(1) FREQUENCY R ENGAGES IN VIGOROUS ACTIVITIES FOR AT LEAST 10 MINUTES

How often do you do vigorous activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate?

FREQUENCY:________________ (Enter a number)

SELECT TIME UNIT:

1 Per day
2 Per week
3 Per month
4 Per year
5 Unable to do this activity

(2) LENGTH OF TIME OF VIGOROUS ACTIVITIES EACH TIME

About how long do you do these vigorous activities each time?

LENGTH: ________________ (Enter a number)

SELECT TIME UNIT:

1 Minutes
2 Hours

2. Moderate Activity

(1) FREQUENCY R ENGAGES IN LIGHT OR MODERATE ACTIVITIES FOR AT LEAST 10 MINUTES

How often do you do light or moderate activities for at least 10 minutes that cause only light sweating or slight to moderate increase in breathing or heart rate?

FREQUENCY:________________ (Enter a number)

SELECT TIME UNIT:

1 Per day
2 Per week
3 Per month

4 Per year
5 Unable to do this activity

(2) LENGTH OF TIME OF LIGHT OR MODERATE ACTIVITIES EACH TIME

About how long do you do these light or moderate activities each time?

LENGTH: ________________ (Enter a number)

SELECT TIME UNIT:

1 Minutes
2 Hours

Health Attitude Survey Question

When you buy a food item for the first time, how often would you say you read the nutritional information about calories, fat and cholesterol sometimes listed on the label - would you say always, often, sometimes, rarely or never?

0 Don't buy food
1 Always
2 Often
3 Sometimes
4 Rarely
5 Never

APPENDIX III. PHYSICAL ACTIVITY CODING GUIDE FOR OCCUPATIONS[30]

Code 1 – very light/light occupations
Code 2 – moderate occupations
Code 3 – hard occupations

Very Light /Light Occupations–Average 1.5 METs–Occupation Activity Code 1

Very light occupations involve mainly sitting, including office or clerical work, the use of light tools, light assembly or repair.

Chemistry lab work
Factory work – very light (involving mainly sitting)
Office or clerical work
Printing
Student – including subjects with no aspect of physical activity, mainly attending lectures and reading or studying
Typing – including electrical, manual or computer

Light occupations involve mainly standing or walking, but no heavy lifting or carrying, including operating automated machinery.

Cleaning – light (including mainly dusting, straightening up, emptying rubbish bins)
Cooking or food preparation
Factory work – light (involving mainly standing or walking)
Machine tooling, working with sheet metal
Laundry work
Repair work (including electrical)
Shoe repair
Tailoring – including cutting, hand or machine sewing

Moderate Occupations–Average 4.0 METs–Occupation Activity Code 2

Occupations that involve mainly walking, lifting or carrying light loads

Carpentry
Cleaning work – hard (including mainly scrubbing floors, sweeping, washing windows, mopping)
Delivery work – light (mainly driving and the lifting of light loads)
Electrician
Factory work – moderate (involving mainly lifting, carrying light loads or operating heavy machinery)

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[30] Source:2002, Physical Activity Diary Code Guide for Occupations, *Food Standards Agency,* http://www.food.gov.uk/multimedia/pdfs/ndnsappendixi03.pdf#page=1, last access on July 11, 2009.

Locksmith
Masseuse
Painting and decorating, including hanging wallpaper
Plumbing
Police work
Farming – light (including feeding small animals, shoveling grain)

Hard Occupations–Average 6.0 METs–Occupation Activity Code 3

Occupations that involve mainly hard physical labor

Coal mining
Delivery work – hard (mainly walking, lifting and carrying heavy loads)
Factory work – hard (involving mainly carrying heavy loads, shoveling, rolling steel)
Farming – hard (including baling hay, poultry work, forking straw bales)
Fire fighter
Laborer – any job involving carrying heavy loads, shoveling, digging
Road or house construction (including driving heavy machinery)
Using heavy power tools e.g. pneumatic drill

APPENDIX IV. ACCRA PRICES

Food and Drink Items in Each Food Group and Unit Prices

Price Categories	Items
PMF	T-bone Steak, Ground Beef or Hamburger, Sausage, Frying Chicken, Chunk Light Tuna
PDAIRY	Whole Milk, grated Parmesan Cheese, Eggs, Margarine
PFFV	Fresh Bananas, Fresh Potatoes, Fresh Iceberg Lettuce
PPFV	Frozen Corn, Canned Peaches, Orange Juice, Canned Tomatoes, Canned Sweet peas
PALC	Liquor, Beer, Wine
PNALC	Vacuum-packed Coffee, Coca Cola
PFF	Hamburger Sandwich, Pizza, Fried Chicken
PHC	Office Visit, Optometrist; Office Visit, Doctor; Office Visit, Dentist; Ibuprofen

Price per Unit

Category	Item No.	Item	Description
PMF	1	T-bone steak	Price per pound
	2	Ground beef or hamburger	Price per pound, lowest price
	3	Sausage	Price per pound; Jimmy Dean or Owens Brans, 100% pork
	4	Frying chicken	Price per pound, whole fryer
	5	Chunk light tuna	6.0 oz. can, Starkist or Chicken of the Sea
PFFV	1	Bananas	Price per pound
	2	Potatoes	10 lb., white or red
	3	Iceberg lettuce	Head, approximately 1.25 pounds
PPFV	1	Frozen corn	16 oz. whole kernel, lowest price
	2	Peaches	29 oz. can, Hunt's, Del Monte, Libby's or Lady Alberta, halves or slices
	3	Fresh Orange Juice	64 oz. (1.89 liters) Tropicana or Florida Natural brand
	4	Tomatoes	14.5 oz. Can, Hunt's or Del Monte
	5	Sweet peas	15-17 oz. can, Del Monte or Green Giant
PDAIRY	1	Whole milk	Half-gallon carton
	2	Eggs	One dozen, Grade A, Large
	3	Margarine	One pound, cubes, Blue Bonnet or Parkay
	4	Parmesan cheese, grated	8 oz. canister, Kraft brand

Category	Item No.	Item	Description
PALC	1	Liquor	J&B Scotch, 750-ml.bottle
	2	Beer	Heineken's, 6-pack, 12-oz. containers, excluding the deposit
	3	Wine	Livingston Cellars or Gallo Chablis or Chenin Blanc, 1.5-liter bottle
PNALC	1	Coffee, vacuum-packed	11.5 oz. can, Maxwell House, Hills Brothers, or Folgers
	2	Soft drink	2 liter Coca Cola, excluding any deposit
PFF	1	Hamburger sandwich	¼-pound patty with cheese, pickle, onion, mustard, and catsup. McDonald's Quarter-Pounder with cheese, where available
	2	Pizza	11"-12" thin crust cheese pizza. Pizza Hut or Pizza Inn where available
	3	Fried chicken	Thigh and drumstick, with or without extras, whichever is less expensive, Kentucky Fried Chicken or Church's where available

Note that the average price of category k across all the participating cities is equal to1.

Let

P_{ki} – Price index of category k at city i

P_{kji} – Price of item j in category k at city i

$avgP_{kj}$ – Average price of item j in price category k across all the participating cities in ACCRA

W_{kj} – Weight of item j counted in price category k ($\sum_j W_{kj} = 1$ for any k)

Then,

$$AvgP_k = \frac{\sum_i P_{ki}}{n} = \frac{1}{n}\left(\frac{\sum_i P_{k1i}}{AvgP_{k1}} W_{k1} + \frac{\sum_i P_{k2i}}{AvgP_{k2}} W_{k2} + \cdots\cdots + \frac{\sum_i P_{kji}}{AvgP_{kj}} W_{kj} + \cdots\cdots + \frac{\sum_i P_{kJi}}{AvgP_{kJ}} W_{kJ} \right)$$

$$= \frac{1}{n}\left(\frac{n \cdot AvgP_{k1}}{AvgP_{k1}} W_{k1} + \frac{n \cdot AvgP_{k2}}{AvgP_{k2}} W_{k2} + \cdots\cdots + \frac{n \cdot AvgP_{kj}}{AvgP_{kj}} W_{kj} + \cdots\cdots + \frac{n \cdot AvgP_{kJ}}{AvgP_{kJ}} W_{kJ} \right)$$

$$= W_{k1} + W_{k2} + \cdots\cdots + W_{kj} + \cdots\cdots + W_{kJ}$$

$$= 1$$

Where, n is the number of participating cities, J is the number of items belongs to category k

Similarly, the average price of category k across all the participating states is equal to 1. The sample mean of any price variable in this paper is close to 1 for both male sample and female sample, which means that the respondents are almost evenly distributed among the participating cities/states in ACCRA

The following shows how the real price is created, taking *PMF* in San Francisco CA for example. This table presents the prices of items in meat and fish category for San Francisco, CA, mean prices of items over all the participating cities, and weights of each item counted in meat and fish category.

	T-bone Steak	Ground Beef or Hamburger	Sausage	Frying Chicken	Chunk Light Tuna
Price	9.32	3.14	4.78	1.55	0.99
Mean Price	8.91	2.3	3.38	1.1	0.69
Weight	0.17357513	0.17357513	0.22228	0.217098	0.213472

Then *PMF* for San Francisco, CA is calculated as:

$$PMF = \frac{9.32}{8.91} \cdot 0.17357513 + \frac{3.14}{2.3} \cdot 0.17357513 + \frac{4.78}{3.38} \cdot 0.22228 + \frac{1.55}{1.1} \cdot 0.217098 + \frac{0.99}{0.69} \cdot 0.213472$$
$$= 1.3451$$

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