

ESSAYS ON THE DETERMINANTS AND CONSEQUENCES OF PHYSICAL ACTIVITY

by

JIN WANG

A dissertation submitted to the Graduate Faculty in Economics in partial fulfillment of the requirements for the degree of Doctor of Philosophy, The City University of New York

2013

© 2013

JIN WANG

All Rights Reserved

This manuscript has been read and accepted for the  
Graduate Faculty in Economics in satisfaction of the  
dissertation requirement for the degree of Doctor of Philosophy.

Michael Grossman

---

---

Date

---

Chair of Examining Committee

Merih Uctum

---

---

Date

---

Executive Officer

Michael Grossman

---

Wim P.M. Vijverberg

---

Inas Rashad Kelly

---

Supervisory Committee

THE CITY UNIVERSITY OF NEW YORK

Abstract

ESSAYS ON THE DETERMINANTS AND CONSEQUENCES OF PHYSICAL ACTIVITY

by

Jin Wang

Adviser: Professor Michael Grossman

The first essay focuses on the economic determinants of physical activity. Physical activity can be decomposed by intensity and duration. The intensity of physical activity is defined by total energy consumed on all physical activities divided by total hours. The intensity of an activity is measured by its metabolic equivalent (MET) value per hour. One MET is defined as the energy expended to lie or sit quietly. One novel aspect of the study is an investigation of the hypothesis that, because their time is more valuable, higher wage individuals may choose to exercise more intensively but for shorter durations. That hypothesis and others are explored in the context of fully specified demand functions for the duration and intensity of activities performed in the market and nonmarket sectors. The instrumental variable method is adopted to estimate the demand functions in which the endogenous variable leisure physical activity is included. Econometric issues related to omitted variable bias and selection bias are addressed as part of the empirical investigation.

The second essay investigates to what extent physical activity influences health status. To study the heterogeneous effects of physical activity on dichotomous health outcome for three groups of people, the analyses of three stratifications are conducted for education, occupation, and physical activity intensity. Probit (ordered probit) models are utilized to address the research

question. I find that for less educated or white collar workers, a rise in average physical intensity increases the probability of reporting very good or excellent health, while longer time spent on physical activity may benefit health for highly educated workers.

Both essays use two main separate data sets: the Current Population Survey (CPS) supplement data set and American Time Use Survey (ATUS). In addition, information on geographic level measures, regional business pattern, and regional crime reports are appended to the primary data from such sources as the U.S. Census County Business Patterns and the Federal Bureau of Investigation's Uniform Crime Reports.

## ACKNOWLEDGMENTS

I owe a great debt to Professor Michael Grossman who is not only my dissertation supervisor but also a lifelong idol. My family aside, he is the finest person who I have ever met. His sense of humor makes my academic days and nights more fun. I also owe a great thanks to Professor Wim P.M. Vijverberg. His tireless cautiousness in reading my research drafts encourages me for a long time. I should give special thanks to Professor Inas Rashad Kelly. She attended my dissertation defense meeting with her newborn baby. Her expertise and friendliness will remain in my mind. Additional thanks go to many members at New York Office of the National Bureau of Economic Research.

Behind every success in my long academic journey, my father, Chuande Wang, and my mother, Aiyun Li, always give me supports without any reservations. This success also belongs to them. I should also thank my father in law, Nengxing Wei, for his generosity and love.

My wife, Jing Wei, shares this dissertation with me. Without her, I could not have accomplished so much. I am very happy that she will receive her Ph.D. degree in Education in New York University in 2014.

## TABLE OF CONTENTS

<b>LIST OF TABLES</b> .....	viii
<b>I DO HIGHER WAGE PEOPLE EXERCISE FOR LESS TIME BUT MORE INTENSELY?</b> .....	<b>1</b>
1.1 Introduction .....	1
1.2 Model .....	2
1.3 Data .....	4
1.4 Empirical Analysis .....	7
1.4.1 Descriptive Statistics .....	7
1.4.2 Multivariate Analysis .....	9
1.4.2.1 OLS for Exogenous Leisure Physical Activity .....	9
1.4.2.2 2SLS for Endogenous Leisure Physical Activity .....	15
1.4.2.3 Probit Model for Positive Leisure Physical Activity .....	16
1.4.2.4 Models Conditional on Positive Leisure Physical Activity .....	17
1.5 Conclusion .....	25
<b>II DETERMINANTS OF HEALTH: LEISURE PHYSICAL ACTIVITY INTENSITY AND DURATION</b> .....	<b>27</b>
2.1 Introduction .....	27
2.2 Model .....	29
2.3 Data .....	30
2.4 Empirical Analysis .....	34
2.4.1 Descriptive Statistics .....	34
2.4.2 Multivariate Analysis .....	37
2.5 Conclusion .....	60
<b>REFERENCES</b> .....	<b>86</b>

## LIST OF TABLES

1	Descriptive Statistics: Means of Main Variables in Four Samples .....	63
2	Means of LPA duration, LPA and LPA intensity in different groups of sampled individuals .....	64
3	OLS estimates for leisure physical activity intensity as dependent variable (including exogenous variable LPA) .....	65
4	OLS estimates for leisure physical activity duration as dependent variable (including exogenous variable LPA) .....	66
5	2SLS estimates in three baseline models (including endogenous variable LPA) .....	67
6	Probit models for positive leisure physical activity (LPA>0) as dependent variable ....	68
7	OLS estimates for leisure physical activity intensity as dependent variable conditional on positive LPA (including exogenous variable LPA) .....	69
8	OLS estimates for leisure physical activity duration as dependent variable conditional on positive LPA (including exogenous variable LPA) .....	70
9	OLS estimates for the ratio of LPA intensity to duration as dependent variable conditional on positive LPA (including exogenous variable LPA) .....	71
10	2SLS estimates in three baseline models conditional on positive LPA (including endogenous variable LPA) .....	72
11	2SLS estimates in three logarithmic baseline models conditional on positive LPA (including endogenous variable LPA) .....	73
12	Descriptive Statistics: Means of main variables in four samples .....	74
13	Means of the leisure PA duration, leisure PA and leisure PA intensity over different years	75
14	Means of the dichotomous health variable in different subgroups of sampled individuals	76
15	Probit models for the LPA intensity and duration effects on the health outcome .....	77

16	Probit models for the LPA intensity and duration effects on health conditional on the low educated individuals .....	78
17	Probit models for the LPA intensity and duration effects on the health outcome conditional on the intermediately educated individuals .....	79
18	Probit models for the LPA intensity and duration effects on the health outcome conditional on the highly educated individuals .....	80
19	Probit models for the LPA intensity and duration effects on the health outcome conditional on the light-intensity LPA .....	81
20	Probit models for the LPA intensity and duration effects on the health outcome conditional on the moderate-intensity LPA .....	82
21	Probit models for the LPA intensity and duration effects on the health outcome conditional on the vigorous-intensity LPA .....	83
22	Probit models for the LPA intensity and duration effects on the health outcome conditional on blue-collar workers .....	84
23	Probit models for the LPA intensity and duration effects on the health outcome conditional on white-collar workers .....	85

## CHAPTER I

### DO HIGHER WAGE PEOPLE EXERCISE FOR LESS TIME BUT MORE INTENSELY?

#### 1.1 Introduction

The issue of exercise intensity has drawn attention in the field of health economics. Researchers (e.g., Meltzer & Jena, 2010; Maruyama & Yin, 2012) have been interested in the relations between wage and exercise intensity and duration. They hypothesized that higher wage individuals may choose to exercise more intensively but for shorter durations because the opportunity cost of time is higher for this group. Meltzer and Jena (2010) found a positive association between family income (as an indirect measure of wage) and the intensity of exercise using the data set of National Health and Nutrition Examination Surveys (NHANES) that were conducted in the United States. They found that as family income increases, the intensity of exercise also increases, holding the other determinants constant. Maruyama and Yin (2012) aimed to test if the same pattern occurs among observations in an Australian based data set that was collected by National Health Survey conducted by Australian Bureau of Statistics. Their analysis suggested similar findings: the exercise intensity increases but exercise time decreases as personal income (as an indirect measure of wage) increases. Saffer, Dave, Grossman and Leung (2011) examined the associations between physical activity (includes leisure and non-leisure) and race, ethnic, and gender differentials using the American Time Use Survey dataset. They found that as wage increases physical activity increases when they used the dependent variable physical activity by intensity and duration. However, none of these studies made a conclusion about the relation between the wage rate and exercise intensity and duration. Also,

confounding effects on endogenous variable leisure physical activity have not been manipulated adequately.

Compared to prior studies except for Saffer et al., this study uses a large data set (n is larger than 30,000) to resolve the potential of biasness for small data sets. In addition, wage is better measured. Instead of using family income (Meltzer & Jena, 2010) and personal income or education as a proxy for the value of time (Maruyama & Yin, 2012), this study uses an hourly wage rate of the sampled individual as a direct measure of the value of time to eliminate the measurement error introduced by the wage of the spouse or asset income when one uses the indirect measures above. In addition, these two studies differ from my study because they do not consider non-exercise leisure physical activity. Furthermore, the exercise leisure physical activity is based on past month (Meltzer & Jena, 2010) or past two weeks (Maruyama & Yin, 2012) recall measures of leisure physical activity. Besides, my study does not constrain health-related physical activity to exercise, but expanded to 77 leisure physical activities. Finally, the intensity of leisure physical activities are not measured by samples' self evaluation such as moderate or vigorous exertion, but only by objective measures of calories consumed by each leisure physical activity. The former method used in Meltzer and Maruyama's papers may cause inconsistent self evaluation among different individuals.

This paper will investigate the wage effect on leisure physical activity intensity, duration and the ratio of intensity to duration separately for people who are employed and who also have observed hourly wage.

## **1.2 Model**

This paper follows the model used in Meltzer and Jena (2010) and uses the utility maximization model with the arguments of health (H), leisure physical activity intensity (I), and

market goods (X):  $U=U(H,I,X)$ . The assumptions of the model are: i) the marginal utility of health is positive: as the value of health increases, utility increases; ii) the marginal utility of physical activity intensity is negative: the more intense one exercises, the more likely that people feel fatigue and get injured; iii) the marginal utility of market goods is positive: the more money one purchases health related goods, such as medical care and nutritious food, the more healthy the one is; iv) health (H) is produced by leisure physical activity (LPA). The health production function can be expressed by  $H = (T, I)$  where T are hours on leisure time and I is leisure physical activity intensity. A special case of the health production function can be  $LPA = T \times I$  if health is only determined by leisure physical activity; v) there are time constraints (i.e., 24 hours a day spent on leisure activities and work) and budget constraints (i.e., the market goods multiplied by their price is equal to endowment plus the number of hours for work multiplied by the hourly wage). The time constraint is defined by:  $L+V=24$ , where L is time spent on non-work activity, V is time spent on work, and 24 is the number of hours per day. Budget constraint is defined by:  $WV+E=pX$ , where W is hourly wage rate, E is endowment income, p is price for goods, and X is market goods.

In the utility maximization model, H is health, I is the intensity of leisure physical activity, and X is a vector representing market goods. The utility function is maximized with respect to the time constraints and budget constraints. If the above simple health production function ( $LPA = T \times I$ ) is assumed, two theoretical results can be derived as: (1) with LPA fixed, as wage increases, I increases and T decreases; (2) with both LPA intensity and duration increased, as wage increases, the ratio of I to T increases. I test these two specific results in this paper which can be also applied to a general health production function.

In the data set, LPA is measured by 77 variables of leisure activities (e.g., bowling, jogging, walking, gaming and watching sports). LPA is defined by a sum of multiplication of time spent and physical activity intensity of each activity. This relationship can be represented by

$$LPA = \sum_{j=1}^n (t_j \times I_j), \quad n = 77 \quad (1)$$

The left hand side of the equation is physical activity. The right hand side is the sum of 77 leisure activities:  $t_j$  is the time spent on the  $j^{\text{th}}$  activity;  $I_j$  is the physical activity intensity of the  $j^{\text{th}}$  activity. Following the measures used in Meltzer and Jena (2010), I use Metabolic Equivalent (MET) values to measure physical activity. The MET measure is considered as more accurate measure of physical activity compared with self report ‘strength’ from sampled participants.

This paper decomposes LPA (2) into two components (3) and (4). T is defined by (3): the total number of hours (or duration) spent on leisure activities is equal to the sum of the time spent on each individual leisure activity. I is defined by (4): the average intensity of the leisure activities is measured by a weighted average across all leisure activities for individuals who have positive leisure time. For those who reported zero leisure time, I is set to equal zero.

$$LPA = T \times I, \quad (2)$$

$$T = \sum_{j=1}^n t_j, \quad n = 77 \quad (3)$$

$$I = \frac{LPA}{T} = \sum_{j=1}^n \left( \frac{t_j}{T} \times I_j \right) = \frac{\sum_{j=1}^n (t_j \times I_j)}{T}, \quad n = 77 \quad (4)$$

### 1.3 Data

In this paper, the dataset combines the American Time Use Survey (ATUS) data set and Current Population Survey (CPS) data set. The CPS data were collected by interviewing the

selected households by two contacts, four months each time, with an eight-month gap between the two interviews. The households that completed the two interviews conducted by CPS were invited for ATUS interviews that were conducted 2-5 months after the CPS interviews since 2003. For example, the samples that constitute in the ATUS 2011 data are the same cohort as those for CPS data from August 2010 to October 2011. Participants selected in ATUS are interviewed once to report all activities of 24 hours starting from 4:00 am previous day to 4:00 am interview day. As a result, the ATUS are cross-sectional dataset. Although the ATUS data are oversampled in Hispanic or non-Hispanic black households, sampling weights are available to deal with population estimation bias.

This paper uses the 2003-2011 waves of ATUS and CPS. The 2011 wave of ATUS is the most recent as of December 2012. Compared to the 2003-2009 waves, the sample size in the 2003-2011 waves has been increased by 26.06%, and variables, such as MET, geographic and county-level business and environmental information that can be used as control variables in regression analyses, have also been added. Also, the countywide monthly unemployment rate has been added as an instrument variable for endogenous model from the source of Local Area Unemployment Statistics at Bureau of Labor Statistics. The CPS and ATUS only conducted health related interview questions from 2006 to 2008, and therefore the data set used in this paper only includes self reported health data from 2006-2008 waves.

To test the hypothesis of causality between wage and intensity, I use the average intensity of all 77 leisure activities, time and the ratio of the intensity to time as dependent variables. The independent variables are an hourly wage rate, age, demographic information, countywide monthly unemployment rate, county-level business and environmental factors, geographic

location, time of the ATUS interview and LPA. The age, demographic, business and environmental factors, and family structure variables are included to control for the opportunity cost of time, and the geographic information is included to control for the unobservable fixed effect. Time of interview including year dummy and month dummy is added to control for seasonal and national trend. The countywide monthly unemployment rate and other county level variables are used as instrumental variables in endogenous models.

The range of age is from 15 to 85 in the entire ATUS sample. In this paper, individuals younger than 18 years old are deleted since those 18 and under are less likely to be in the labor market. Observations in which individuals who are unemployed and whose weekly wages are missing, as well as individuals who are employed but the weekly wage or work hours are missing, are deleted in this paper. The demographic information includes variables of race, gender, marital status, and the number of children younger than 18 per household. All nominal variables including hourly wage rate and annual family income are deflated by the CPI.

The geographic location is defined by county of residence, by which countywide monthly unemployment rate from Department of Labor is linked to the ATUS data set. This variable as well as other county-level variables act as an exclusion restriction in the first stage equation when LPA is treated as an endogenous variable.

Leisure physical activity is defined by the summation of the time spent on each leisure activity (e.g., jogging, bowling, yoga, etc.) multiplied by the intensity of the corresponding activity (e.g., MET/hour). The intensity of the leisure activity is reported by the National Cancer

Institute<sup>1</sup>. One unit of MET is defined by the number of calories consumed by the designated leisure activity in proportion to the number of calories consumed by sitting quietly. For example, the MET value for walking is 2, and the MET value for sitting is 1. Based on the intensity for each activity, this paper calculated the average intensity using a weighted average function that has been described in Equation 4.

Leisure physical activity duration in the dataset is measured by the number of minutes spent on each leisure activity. This paper summed the time for 77 leisure activities and divided the total time in minutes by 60 to get the total time in hours.

Dependent variables are leisure physical activity intensity, leisure physical activity duration, and the ratio of intensity to duration in the data set. A large number of zeros are observed in leisure physical activity duration because the ATUS interview is conducted for leisure activities during 24 hours of the interview day. I will fit separate models with and without the above zero LPAs. Again, this paper only includes observations in which individuals who have positive wages.

## **1.4 Empirical Analysis**

### **1.4.1 Descriptive Statistics**

Table 1 reports the results of the test for sample selection bias. Since the entire sample does not include data for all variables, the analyses conducted with each sub sample (with reported data for a given variable) may result in a selection bias. For example, the sample size for the sub sample with county of residence and countywide monthly unemployment rate

---

<sup>1</sup>The MET values for a large number of activities are also contained in the Compendium of Physical Activities Tracking Guide (CPA) (Ainsworth, 2002).

reported is 54,377; the sample size of the sub sample with county of residence and county level business and environmental information is 30,758. The total ATUS sample size is 124,517. To test the potential of selection bias, this paper compares the mean of each sub sample with the mean of total data set. The results showed that the selection bias does not exist. For example, with respect to the variable health, the mean for the sub sample with environmental variables reported is 3.530 and the mean for the sub sample with county of residence reported is 3.533. If one compares the mean for each sub sample with the mean of the entire data set (i.e., 3.521), the differences are no larger than 0.34%. However, it has been noted that for some variables there are slightly larger differences between the means of the sub sample with environmental variables reported and the means of the entire data set. For example, the mean of wage for the sub sample is 9.951. Compared with the mean of wage for the entire data set (9.349), the difference is 6.4%. The mean of leisure physical activity (LPA) for the sub sample with environmental variables reported is 1.581. Compared with the mean of LPA for the entire data set (1.506), the difference is 5.0%. Differences between the sub sample with county of residence reported and the entire data set are less due to significantly larger sample size. To address this issue in my future studies, I will use both sub samples with and without environmental variables in which the differences fall down largely when the sample size enlarges from 30,758 to 54,377.

Table 2 explains the changes in Leisure Physical Activity Duration (T), Leisure Physical Activity (LPA), and Average Leisure Intensity (I) with changes in different age and hourly wage groups in the entire sample. As age increases, T decreases with an exception of the 4th (age 35-39) and 9th (age 60-64) category, and LPA decreases with similar pattern as T. As age increases, I reaches a peak at the 5th (age 40-44) category. The patterns are different for hourly wage rate. As wage increases, the time slightly decreases first, drops to the lowest value at the second

category (hourly wage from \$3.42 to \$4.31), and continuously increases until the seventh category (hourly wage from \$8.38 to \$10.54). The time climbs to its peak at the tenth category (hourly wage from \$17.65 to \$509.02). A similar pattern is observed for LPA. For I, it stays flat for the first two categories (hourly wage from \$0 to \$3.41 and \$3.41 to \$4.31) and increases to the first peak at the third category (hourly wage from \$4.32 to \$5.23), then falls down and rise up to the second peak at the sixth category (hourly wage from \$7.41 to \$8.82), then keeps flat until the ninth category (hourly wage from \$13.05 to \$17.64) and falls down again to the bottom at the tenth category (hourly wage from \$17.65 to \$509.02).

Finally, I checked the weekend effect on leisure physical activity. The means of leisure PA, duration, and intensity are not apart from each other no matter when the ATUS interview is conducted in weekend or weekday.

## **1.4.2 Multivariate Analysis**

### **1.4.2.1 OLS for Exogenous Leisure Physical Activity**

The empirical models are three reduced form input demand functions: the intensity of physical activity (I) is a function of leisure physical activity (LPA) and hourly wage rate (W) (Equation 5); the duration of leisure physical activity (T) is a function of LPA and W (Equation 6); the relative input (I/T) is a function of wage (Equation 7). It is hypothesized that with fixed LPA, I increases with an increase in W and T decreases with an increase in W. People with a high hourly wage rate are more likely to participate in high intensity LPA and to reduce time spent on LPA, because of its high opportunity cost. It is anticipated that this pattern may not be linear for the high rank wage rate population, as their work effectiveness is higher and required work time is shorter. The relative input demand function, represented by Equation 7, is similar to

treating the capital-labor ratio as the dependent variable in a firm production function context; thus, in Equation 7 it is hypothesized that LPA may be relevant to the optimal intensity to time ratio. Under the strict assumption of simple health production ( $LPA = T \times I$ ), the ratio of I to T is expected to increase as wage increases.

$$I = F(LPA, W), \quad (5)$$

$$T = F(LPA, W), \quad (6)$$

$$I/T = F(LPA, W), \quad (7)$$

The demand functions of (5), (6) and (7) can be estimated by the empirical functions of (8), (9) and (10).

$$I = F(LPA, W, \text{Other variables}) + u, \quad (8)$$

$$T = F(LPA, W, \text{Other variables}) + u, \quad (9)$$

$$I/T = F(LPA, W, \text{Other variables}) + u, \quad (10)$$

Other variables, such as geographic location, labor force variable, demographic information, county-level business (e.g. average price of tennis balls, number of recreational goods rentals), environmental factors (e.g., weather condition, crime rate), and county monthly employment rate may be added to control for the potential confounding relation between hourly wage rate and intensity or that between wage rate and duration. Time (month and year) and location (county) fixed effects are implemented in all models to adjust unobserved fixed time and area effects. Standard errors are all adjusted for individuals residing in the same county for each month and year as interviewed.

I first estimate the above input demand functions (8) and (9) with OLS. The results in table 3-4 show the OLS estimates with LPA as an exogenous variable. As with all other results that I present in this paper, observations with zero or missing wages are excluded from samples. The addition of LPA is valid if LPA has no correlation with other unobserved factors and enable us to measure the effect of wage on the dependent variables is observable holding total leisure physical activity constant. Since a large number of observations (82%) who have zero LPAs, I use the two part models to deal with this issue in table 7-8.

In table 3, the dependent variable is leisure physical activity intensity. In the first specification (baseline model), the independent variables are demographic variables (i.e., race, age, and gender) and hourly wage. In the second specification, except for the variables included in the first specification, time constraints variables are added. The time constraints variables are: family income, the number of children younger than 18 per household, and marital status of the interviewee. In the third specification, in addition to the independent variables included in the first specification, county level business and environmental variables are added to control for the price of market goods. Part time job and county monthly unemployment rate are also included as independent variables. The fourth specification covers all variables used in the previous three specifications. Compared to the original ATUS and CPS datasets, the sample sizes of the four specifications are smaller, because of the addition of country level variables and deleted non-positive values in variable hourly wage. In the larger dataset, the number of observations is 28,551. However, only 16,437 observations have county level environmental information, and including all variables reduces the sample size of the fourth specification to 14,506. The following paragraphs will report the results of the four specifications.

In the first specification, in terms of the hourly wage, people who earn one more dollar raise the intensity of their leisure physical activity by 0.007 MET/hour; this effect is statistically significant. Asians have a significant lower leisure intensity of 0.010 MET/hour than that of whites. Blacks, Hispanics, and other race have significant lower leisure intensity than that of whites. Compared to females, males have less intense leisure activity by 0.060 MET/hour. The coefficient estimate of LPA is 0.302 MET/hour, which is significant at one percent significance level. For age, the estimate is close to zero and insignificant.

In the second specification, after controlling for time constraints variables, the coefficient for wage and other races become smaller. This means that the wage effect and the other races effect contribute less in leisure physical activity intensity than that in the first specification. The gender effect increases slightly. Age effect becomes statistically significant and doubles in absolute value. As for the time constraint variables, annual family income and the number of children have statistically significant impacts on intensity. As the family income increases by \$1,000, the intensity increases by 0.004 MET/hour. One more child contributes to less intense leisure physical activity by 0.027 MET/hour. Married people have an insignificant higher intense leisure physical activity than unmarried by 0.005 MET/hour. The coefficient on LPA does not change.

The third specification suggests that the addition of county level variables has some change in the coefficients on the variables that are included in the first specification. Asians, blacks, and Hispanics have less intense leisure activity compared to whites than that in the first specification. With regard to county level variables, the regression analysis result shows that they

do not have statistically significant impact on the intensity except for the number of recreational equipment rental store. The coefficient on LPA has little change.

The fourth specification shows that the addition of time constraints does have slight impact on the other coefficients compared to the third specification. The wage effect is smaller and age effect becomes significant and larger. The coefficient on LPA remains significant and similar to previous specification.

In Table 4, the dependent variable is leisure physical activity duration. In the first specification, in terms of the hourly wage, people who earn one more dollar have little change (less than 0.001 hours or 3.6 seconds) in time spent on leisure physical activity. All of the race variables except for other race have statistically significantly negative impacts on time compared to the white. Asians spend 0.029 hours on leisure physical activity less than whites; those who are black spend 0.013 hours on leisure physical activity less than whites; and Hispanics have 0.013 hours on leisure physical activity less than whites. Other race people have 0.001 hours on leisure physical activity less than whites while the estimate is not significant. It is worth noticing that the race effects on duration decrease dramatically compared to that in the specification with no exogenous LPA. Males have more time spent on leisure physical activity than females by 0.013 hours. Age effect decreases to zero. The coefficient on LPA is highly significant.

In the second specification, after controlling for time constraints variables, the absolute value of the coefficients for hourly wage decreases to one third of that in the first specification and also becomes statistically insignificant, which indicates that the wage effect in the time spent on leisure activities becomes trivial. The coefficient on Hispanics becomes smaller in absolute value and insignificant. As for the time constraint variables, marital status and family income are

statistically significant. The effects of marital status and the number of children are negative on leisure physical activity duration holding other independent variables constant. Family income has a close zero positive impact on duration. The coefficient on LPA barely changes.

The third specification suggests that the addition of county level variables result in much change in the coefficients on the variables that are included in the first specification. The race variables, gender, age and wage all become statistically insignificant. One exception is that the coefficient on Asians remains the same. With regard to county level variables, the regression analysis result shows that they have a statistically significant impact on the time spent on leisure time activity. Two county level environmental variables, pedestrian fatality and unemployment rate have significant negative impacts on time spent on leisure physical activity. Every 1000 sports rental stores contribute 3.415 hours spent on leisure physical activity. The LPA effect remains the same.

The fourth specification shows that the addition of time constraints and county level variables makes little change of coefficients. It is worthy to noting that the wage effect turns to be negative though it is still insignificant after controlled for time constraint and money constraint factors, which means that the baseline model in the first specification may suffer from omitted variable bias. The coefficient on LPA does not change. Finally, the R-squared is 0.864 which suggests that the fourth specification is the best fit linear model among all four specifications.

Compared with the model in Tables 3-4, corresponding natural logarithm forms of dependent variables as well as some independent variables such as wage and LPA are also checked. Since the results in the natural logarithm models are similar to previous models, I do

not report them in this paper. The results for the ratio of leisure activity intensity to duration as the dependent variable are not reported here either because I will include them in the following sections.

#### **1.4.2.2 2SLS for Endogenous Leisure Physical Activity**

The results in Tables 3-4 are not satisfactory to the hypotheses because the coefficients on wage are not stable in terms of sign and magnitude. This may be caused by endogenous LPA. I will conduct a two stage least squares method (2SLS) to estimate the wage effect in the baseline model.

Table 5 reports the results from the second stage of the 2SLS model. The dependent variables are time spent on leisure physical activity (duration) and leisure physical activity intensity. The LPA is treated as an endogenous variable in Table 5. Using the 2SLS method in all three baseline models, the dependent variable in the first stage is LPA and independent variables are holiday, weekday, children, married, part time, county monthly unemployment rate, crime, pedestrian fatality, sports rental, density, temperature, temperature sq and precipitation. Although the results are not reported, the F test of joint significance and overidentification test are conducted. The null hypotheses in both tests are rejected at ten percentage points.

When the dependent variable is leisure physical activity duration, the estimate results show that wage effect is negative and close to zero. An individual who earns one more dollar will have a little less time spent on leisure physical activity. Age has a small positive effect on duration. The LPA effect is highly significant. Other coefficients are all statistically insignificant. When the dependent variable is leisure physical activity intensity, all independent variables have significant coefficient estimates except for Asians. For wage, one more dollar in the wage

increases intense leisure physical activity by 0.011 MET/hour. Age has a negative impact on intensity by 0.005 MET/hour. Whites have more intense leisure physical activity than people of other race. The gap between whites and blacks is as large as 0.289 MET/hour.

### **1.4.2.3 Probit Model for Positive Leisure Physical Activity**

The endogenous models have more attractive results to support our underlying hypotheses though some estimates of wage effect are not significant, which may be caused by large number of zeros in dependent variables. I will test on smaller samples with only individuals who have positive leisure physical activity in the next section. The results of the second stage are not reported in this paper. Instead, I will report the results of probit models when the dependent variable is dummy variable for leisure physical activity. Positive leisure physical activity makes the dummy equal to one; otherwise the dummy equals zero. No missing value in leisure physical activity. In Table 6, the marginal effects of independent variables on the probability of positive leisure physical activity are calculated and reported. In the baseline specification, the marginal effect of wage on the probability of doing LPA is around 0.3 percentage points, which means that higher hourly wage increases the probability of having leisure physical activity holding other variables constant. All race variables have a lower probability of having leisure physical activity than whites. Males are more likely to have LPA than female by 3.3 percentage points. One year older contributes less change to have LPA by 0.1 percentage points.

In the second specification, after adding time constraints variables, the marginal effects of race, gender, and age are similar to that in the first specification. Family income increases the probability of positive LPA by 0.2 percentage points. Having one more child under 18 years old

lowers the probability of positive LPA by 1.2 percentage points. Married people have lower probability having LPA by 2 percentage points.

The third specification deletes the time constraints variables and adds county level business and environmental variables on the basis of the first specification. The results suggest that the addition of county level variables do not result in much change in the coefficients on the variables that are included in the first specification. The marginal effect of other race does not change but is not statistically significant as before. With regard to county level variables, the hypothesis of adding these variables is that they are the proxies of either market goods prices or opportunity cost of the leisure physical activity. However, the regression analysis result shows that they do not have statistically significant impact on the probability of the leisure activity intensity, except for the temperature.

The fourth specification is the full model with all the variables that have been used in the previous three specifications. The results show that the addition of time constraints and county level variables does not result in much change in the coefficients.

#### **1.4.2.4 Models Conditional on Positive Leisure Physical Activity**

Tables 7-8 report the results of four regression analyses with similar specifications to those in Tables 3-4 with the exception of excluding zero values in LPA as well as leisure physical activity intensity and duration. Limiting to the samples with positive leisure physical activity makes sample size much smaller but may reach more stable estimates. In Table 7, the dependent variable is leisure physical activity intensity. In the first specification, in terms of the hourly wage, people who earn one more dollar have higher statistically insignificantly intense leisure physical activity by 0.001 MET/hour. Asians have a significant higher leisure intensity of

0.072 MET/hour than that of whites. Blacks, Hispanics, and other race have significant lower leisure intensity than that of whites. Compared to females, males have less intense leisure activity by 0.155 MET/hour. The coefficient estimate of LPA is 0.082 MET/hour, which is significant at one percent significance level. For age, the estimate is statistically significant - 0.007 MET/hour. The magnitude of all coefficient estimates is noticed to be much larger than that in Table 3 except for the wage effect.

In the second specification, after controlling for time constraints variables, the coefficient for wage, Blacks, and Hispanics become smaller. This means that these three effects contribute less to leisure physical activity intensity than in the first specification. The gender and age effects increase slightly. As for the time constraint variables, family income and the number of child have statistically insignificant impacts on intensity. As the family income increases by \$1,000, the intensity increases by 0.002 MET/hour. One more child contributes to less intense leisure physical activity by 0.006 MET/hour. Married people have a statistically significant higher intense leisure physical activity than unmarried by 0.223 MET/hour. The coefficient on LPA does not change.

The third specification suggests that the addition of county level variables has some change in the coefficients on the variables that are included in the first specification. Other race and Hispanics have less intense leisure activity compared to whites than that in the first specification. Gender and age also have negative impacts on leisure physical intensity. With regard to county level variables, the regression analysis result shows that they do not have statistically significant impact on the intensity except for the number of recreational equipment rental store and county monthly unemployment rate. The coefficient on LPA has little change.

The fourth specification shows that the addition of time constraints does have some impact on the other coefficients compared to the third specification. The wage effect and the age effect are larger. The coefficient on LPA remains significant and similar to previous specification.

In Table 8, the dependent variable is leisure physical activity duration. In the first specification, in terms of the hourly wage, people who earn one more dollar have little change in time spent on leisure physical activity. All of the race variables except for Asians have statistically insignificantly impacts on time compared to whites. Asians spend 0.148 hours on leisure physical activity less than whites; blacks spend 0.006 hours on leisure physical activity more than whites; and Hispanics have 0.018 hours on leisure physical activity less than whites. Other race people have 0.009 hours on leisure physical activity less than whites. Males spend statistically significantly more time on leisure physical activity than female by 0.077 hours. The age effect on duration closes to zero. The coefficient on LPA is highly significant.

In the second specification, after controlling for time constraints variables, the absolute value of the coefficients for hourly wage becomes a small negative value and remains statistically insignificant, which indicates that the wage effect in the time spent on leisure activities becomes ambiguous. The coefficients on all race variables become larger in absolute value. As for the time constraint variables, marital status is -0.057 hours and statistically significant. The effect of one more child leads 0.012 hours on leisure physical activity duration holding other independent variables constant. Family income has a close zero negative impact on duration. The coefficient on LPA barely changes.

The third specification suggests that the addition of county level variables result in much change in the coefficients on the variables that are included in the first specification. The gender

effect becomes statistically insignificant. The wage effect is statistically insignificant positive value (less than 0.001 hours). With regard to county level variables, the regression analysis result shows that they have statistically significant impact on the time spent on leisure time activity. Two county level environmental variables, pedestrian fatality and unemployment rate, have statistically significant negative impacts on time spent on leisure physical activity. Every 1000 sports rental stores contribute 29.27 hours spent on leisure physical activity. One percentage point higher in county monthly unemployment rate contributes to 0.087 hours spent on leisure physical activity. The LPA effect remains the same.

The fourth specification shows that the addition of time constraints and county level variables makes some change of coefficients. It is worthy to note that the wage effect turns to be negative though it is still insignificant after controlling for time constraint and money constraint factors, which means that the baseline model in the first specification may suffer from endogenous LPA problem. The coefficient on LPA does not change. Finally, the R-squared is 0.792 which suggests that the fourth specification is the best fit linear model among all four specifications.

Table 9 reports the results of four regression analyses with the ratio of leisure activity intensity to time spent on leisure activities as the dependent variable. In the first specification, the wage effect on time spent on leisure time activity is a statistically significant negative value of 0.011 MET/hour<sup>2</sup>. The estimate shows that one more dollar in wage results in a decrease of 0.011 on the ratio of intensity to time spent on leisure physical activity, which means people who earn a higher wage prefer less intensity to longer duration of leisure physical activity. This result conflicts with one of the hypotheses if a simple health production function is assumed by

$LPA = T \times I$ . The race effects on the ratio are all statistically insignificant except for other race. Other races have lower ratio by 1.111 than whites.

In the rest of specifications, the wage remains negative. I will use the 2SLS method to cope with potential endogenous variable LPA in the baseline model. In Table 10, the results of three baseline models with leisure physical activity duration, intensity and the ratio of intensity to duration as dependent variables are reported. The first two results are similar to Table 5 except with the smaller sample limited to individuals who have positive leisure physical activity. The dependent variable in the first stage is LPA and dependent variables in the first stage are LPA duration, intensity and the ratio of intensity to duration respectively. Although the results are not reported, the F test of joint significance and overidentification test are conducted. The null hypotheses in both tests are rejected at ten percentage points.

In the first equation where the dependent variable is leisure physical activity duration, the estimation results show that the wage effect is a statistically significant negative estimate of 0.007 hours. The individual who earns one more dollar will have less time spent on leisure physical activity by 0.007 hours. Age contributes 0.005 hours on duration. Males have 0.668 hours spent on leisure physical activity more than females. Asians spend 0.318 hours less on leisure physical activity than whites. Blacks have 1.050 hours leisure time less than whites. Hispanics have 0.155 hours leisure time less than whites. Other race people have 3.617 hours leisure time less than whites. LPA effect is positive and highly significant. All coefficients are statistically significant.

In the second equation where the dependent variable is leisure physical activity intensity, all independent variables have significant coefficient estimates except for Asians. For wage, one

more dollar in wage increases intense leisure physical activity by 0.014 MET/hour. Age has negative impact on intensity by 0.011 MET/hour. All other race people have more intense leisure physical activity than whites. The gap between whites and the other race is as large as 7.606 MET/hour. Males have 1.407 MET/hour less intense leisure physical activity than females. Age has a negative impact on intensity by 0.011 MET/hour.

In the third equation where the ratio of intensity to duration as the dependent variable, all independent variables except for LPA are statistically insignificant. However, the wage effect on the ratio of intensity to duration is positive with a value of 0.008 MET/hour<sup>2</sup>, which means that higher wage leads to higher increment in intensity than that in duration. However, it is not statistically significant at ten percentage significant level. All race people have higher ratios of intensity to duration than whites. Males have a ratio of 0.650 MET/hour<sup>2</sup> less than females. One year older will have lower ratio by 0.017 MET/hour<sup>2</sup>.

To test stability of the estimates in the above baseline model in Table 10, I implement the natural logarithm forms for variables leisure physical activity duration, intensity, the ratio of intensity to duration, LPA, and hourly wage. It is worth noting that there is a mechanical relationship among the three equations. Once one of them estimated, the other two can be obtained. I present all three regressions for illustrative purpose only. To be specific, let I be intensity, T be duration, W be wage rate, R be the ratio of intensity to duration and LPA be the product of I and T. Consider the regression in which  $\ln(I)$  is the dependent variable

$$\ln(I) = \alpha \ln(LPA) + \beta \ln(W). \quad (11)$$

Since  $\ln(I) = \ln(LPA) - \ln(T)$ ,

$$\ln(\text{LPA}) - \ln(\text{T}) = \alpha \ln(\text{LPA}) + \beta \ln(\text{W}).$$

So

$$\ln(\text{T}) = (1 - \alpha) \ln(\text{LPA}) - \beta \ln(\text{W}). \quad (12)$$

$$\text{Now } \ln(\text{R}) = \ln(\text{I}) - \ln(\text{T}).$$

Subtract (12) from (11) to get

$$\ln(\text{R}) = (2\alpha - 1) \ln(\text{LPA}) + 2\beta \ln(\text{W}). \quad (13)$$

The results in Table 11 are reported as the above natural logarithm forms are implemented. Although the results are not reported, the F test of joint significance and overidentification test are conducted. The null hypotheses in both tests are rejected at ten percentage points. In the first equation where the dependent variable is the natural logarithm of leisure physical activity intensity, all independent variables have significant coefficient estimates except for Asians, Black, and Hispanic dummy variables. The wage effect is statistically significant and means one percent increase of hourly wage leading to 0.056 percentage points increase in intense leisure physical activity. The Age effect means that one year contributes a decrease of 0.7 percentage points on intensity. The gender effect means that males have 13.3 percentage points intense leisure physical activity higher than females. Asians have 4.5 percentage points higher in intensity less than whites. Blacks have 2.7 percentage points higher intense leisure physical activity less than whites. Hispanics have 4.7 percentage points lower intense leisure physical activity than whites. Other race people have 177.5 percentage points more intense leisure physical activity than whites. LPA effect is positive and highly significant.

In the second equation, for the dependent variable is the natural logarithm of leisure physical activity duration, the estimate results show that wage effect is statistically significant and means one percent increase of hourly wage leading to 0.056 percentage points decrease in time spent on leisure physical activity. The Age effect means that one year contributes 0.7 percentage points increase on duration. The gender effect means that males spend 13.3 percentage points hours on leisure physical activity more than females. Asians have 4.5 percentage points hours spent on leisure physical activity less than whites. Blacks have 2.7 percentage points hours spent on leisure physical activity less than whites. Hispanics have 4.7 percentage points hours spent on leisure physical activity more than whites. Other race people have 177.5 percentage points hours spent on leisure physical activity less than whites. LPA effect is positive and highly significant. All coefficients are statistically significant except for Asians, Blacks, and Hispanics.

In the third equation, for the natural logarithm of the ratio of intensity to duration as the dependent variable, all independent variables except for Asians, Blacks, and Hispanics are statistically significant. The wage effect on the ratio of intensity to duration is still positive and statistically highly significant. One percent of wage increase results in 0.113 percentage points higher in intensity than that in duration. All race people have higher ratios of intensity to duration than whites except for the Hispanic. Males have a ratio of 26.7 percentage points more than females. One year in age will have lower ratio of 1.5 percentage points.

The results from logarithmic models are consistent to non-logarithmic models in terms of sign on main coefficients. More importantly, these results support the hypotheses that higher wage individuals spend less time but higher intensity on leisure physical activity because of

higher opportunity cost. For the ratio of intensity to duration, higher wage leads to higher ratio because people intend to increase intensity than time spent on leisure physical activity.

## **1.5 Conclusion**

Leisure physical activity duration is an important constraint for people with high hourly wage. Even though they have more resources to invest in health related activities (e.g., eating health food and buying health club membership), the opportunity cost of leisure physical activity is also higher. Therefore, it is reasonable to explore time efficient means that may achieve the same health benefits. This paper hypothesizes that as the wage rate increases the leisure physical activity intensity increases but the time decreases. It conducted regression analyses with different specifications. The 2SLS method is implemented to estimate coefficients because of endogenous leisure physical activity. The regression analyses in the endogenous model indicate that the overall hypothesis of this paper is confirmed. The positive signs of wage coefficients in the regressions with intensity as the dependent variable suggest that higher wage individuals engage in more intense leisure physical activities. The positive signs of wage coefficients with the ratio of intensity to time as the dependent variable show that the higher the wage rate is, the higher the ratio is, which means people intend to choose more intense leisure physical activity than spend more time on leisure physical activity. The positive signs of wage coefficients with time as the dependent variable are also achieved.

One implication of this study is that health practitioners may need to individualize leisure physical activity plan according to people's hourly wage. Common recommendations, such as walking for one hour a day, may not be adhered to by high wage group. Physically more intense but time-wise less intense leisure physical activities are more likely to be adopted by this group.

This study found desirable relation between wage and dependent variables using 2SLS method. Meanwhile, it excludes the samples with zero or missing wage. Future studies should explore the income effect on leisure activity intensity, duration and the ratio of intensity to duration for people who do not work and therefore who have no positive wage. When I use other weekly income to measure wealth effect as no positive wage is observed, results are similar to that in this paper. In another paper, I will conduct a study to investigate consequences of leisure physical activity intensity and duration as the determinants of health outcomes.

## CHAPTER II

### DETERMINANTS OF HEALTH: LEISURE PHYSICAL ACTIVITY INTENSITY AND DURATION

#### 2.1 Introduction

It is well known that health outcomes are associated with physical activity in literatures. This paper studies leisure physical activity (LPA) as an important determinant of health by two separate components, intensity (I) and duration (T). A large number of literatures show that leisure physical activity may be directly beneficial to good health by relieving mental hypertension, keeping fit, reducing cardiovascular related diseases and enhancing longevity; and LPA has an indirectly positive effect on good health by reducing obesity (Lawlor and Hopker, 2001; Colman and Dave, 2012) and lowering morbidity and mortality rates (Colman and Dave, 2012). Little research has focused on exercise intensity impacts on health. Lee et al. (1995) examined how exercise intensity contributes to men's longevity in the Harvard Alumni Health Study. Franc et al. (2005) found that a moderate-intense or vigorous-intense physical activity is highly associated with a longer life expectancy for people who have cardiovascular disease. However this association does not apply to light-intensity physical activities.

Since human health capital and knowledge-based capital are interacted, a lack of human knowledge-based capital does harm health capital accumulation over a life period. Meanwhile, lower health capital can lead to a slower acquisition in knowledge-based capital (Grossman, 1972). Saffer, Dave, Grossman and Leung (2011) studied the association between physical activity (includes leisure and non-leisure) and health outcomes across race, ethnic, and gender

differentials. They found that the race, ethnic, and gender differentials (REG) in the health outcome may result from the REG differentials in physical activities.

All of the above studies are different from this paper because, first of all, this paper uses better measures of leisure physical activity. The papers authored by Lawlor and Hopker (2001), Colman and Dave (2012), Lee et al. (1995) and Franc et al. (2005) used either specific sample surveys such as the Harvard Alumni Health Study or national surveys such as the National Health and Nutrition Examination Surveys (NHANES). However, the Harvard Alumni Health Study data is unlikely to be fully representative of an entire population in the US, and the NHANES has limitations to measure physical activity duration and intensity. For example, the NHANES includes only self-reported “vigorous” or “moderate” as measures of physical activity intensity, which may suffer from inconsistent interpretations across different individuals. Different individuals may have different feelings on “vigorous” exercises which causes a potential reference bias. Moreover, interviewees are asked to report leisure physical activities in the past week or past month in the NHANES, which may cause a potential recall biases. This paper uses the American Time Use Survey (ATUS) data set which has more accurate measures of leisure physical activity, intensity and duration. The intensity of leisure physical activity is measured by Metabolic Equivalent (MET)<sup>2</sup>, which reduced recall biases and measurement errors compared to the studies in Lee et al. (1995) and France et al. (2005). Second, this paper addresses a different research question from above papers: the effects of leisure physical activity intensity and duration on health outcomes after controlling for REG and other environmental variables. On the contrary, Saffer et al. (2011) studied to what extent a physical activity (leisure

---

<sup>2</sup> MET is the ratio of a person’s activity metabolic rate relative to their resting metabolic rate. One MET is defined as the energy that one consumes by sitting or sleeping quietly which is equivalent to a caloric consumption of 1 kcal/kg/hour.

physical activity and non-leisure physical activities) disparity contributes to health differentials across different REG groups. However, they paid little attention on the intensity and duration effects on health outcome separately. This paper will fill this gap in the current literatures.

## 2.2 Model

This paper focuses on the impact of leisure physical activity intensity and duration on the self-reported health outcome. Other factors contributing to the health outcome are included such as county-level business and environmental variables, time and geographic variables. Following the framework of the human capital model for the demand of health (Grossman, 1972), people demand health for the purpose of consumption and investment. For example, an increase of health capital can enhance an individual's utility, decrease the probability of illness and increase earnings (a measure of productivity). The utility maximization model with the arguments of health (H), leisure physical activity intensity (I), and market goods (X) can be expressed by a function:  $U=U(H,I,X)$ . Underlying assumptions of the model are: i) the marginal utility of health is positive: as the value of health increases, utility increases; ii) it assumes that the marginal utility of physical activity intensity is negative: the more intense one exercises, the more likely that people feel fatigue and get injured; iii) the marginal utility of market goods is positive: the more money one purchases market goods, such as medical care and nutritious food, the more healthy the one is; iv) health (H) is a function of leisure physical activity (LPA), other health-related time ( $T_{other}$ ), market goods (X), and efficiency parameter:  $H=H(LPA, T_{other}, X; \text{efficiency})$ . The LPA may be defined by a product of duration and intensity ( $LPA = T \times I$ ) where T are hours spent on leisure physical activity and I is the intensity or energy expenditure (MET) per hour. Therefore, the health production function can be written by:  $H=H(T, I, T_{other}, X; \text{efficiency})$ ; v) there is an individual's cost constraint which is defined by:  $F = WV + pX$ . Total production cost

(F) is equal to the market input cost which is a product of the market goods (X) and the market price (p) plus the time cost valued by a hourly wage rate (W) multiplied by total time spent on health related activity (V). The health related time (V) is equal to a sum of the leisure physical activity duration (T) and the other health related time ( $T_{\text{other}}$ ). Without loss of generality, the other health related time is ignored for simplicity in this paper.

In the above utility maximization model, H is health, I is the intensity of leisure physical activity, and X is market goods. The utility function is maximized with respect to the cost constraint to yield a reduced form demand function for health by

$$H = H(\text{hourly wage rate, price, LPA intensity, LPA duration, other weekly income, race, ethnicity, gender, family structure, age, employment, environment factors, location factors}) \quad (14)$$

In the ATUS data set, the LPA is measured by 77 variables of leisure activities (e.g., bowling, jogging, walking, gaming and watching sports). The LPA is defined by a sum of multiplication of time spent and physical activity intensity of each activity. This relationship is represented in Equation 1.

This paper decomposes LPA in Equation 2 into two components in Equations 3 and 4. T is defined by Equation 3: the total number of hours (or duration) spent on leisure activities is equal to the sum of the time spent on each individual leisure activity. I is defined by Equation 4: the average intensity of the leisure activities is measured by a weighted average across all leisure activities. For those who reported zero leisure time, I is set to equal zero.

### 2.3 Data

In this paper, the dataset combines the American Time Use Survey (ATUS) data set and Current Population Survey (CPS) data set. The CPS data were collected by interviewing the selected households by two contacts, four months each time, with an eight-month gap between the two interviews. The households that completed the two interviews conducted by CPS were invited for ATUS interviews that were conducted 2-5 months after the CPS interviews since 2003. For example, the samples that constitute in the 2011 ATUS data are the same cohort as those for CPS data from August 2010 to October 2011. Participants selected in ATUS are interviewed once to report all activities of 24 hours starting from 4:00 am previous day to 4:00 am interview day. As a result, the ATUS data are cross-sectional. Although Hispanic or non-Hispanic black households are oversampled in the ATUS data, sampling weights are available to deal with population estimation bias.

This paper uses the 2003-2011 waves of ATUS and CPS. The 2011 wave of ATUS is the most recent as of December 2012. Compared to the 2003-2009 waves, the sample size in the 2003-2011 waves has been increased by 26.06%, and variables, such as MET, geographic and county-level business and environmental information that can be used as control variables in regression analyses, have also been added. Also, the countywide monthly unemployment rate has been added as a control variable. Since the CPS and ATUS only conducted health related interview questions from 2006 to 2008, the data set with the self-reported health variable in this paper only covers a span of the 2006-2008 waves.

To examine the hypothesis of association between the health outcome and the LPA intensity, and the health outcome and the LPA duration, probit models will be utilized to

estimate the effects of the intensity and duration on the health outcome. The dependent variable is health (a dichotomous variable) which equals one if interviewees answer very good or excellent to a question about their health status. I use the average intensity of all 77 leisure activities, and hours spent in leisure physical activity (duration) as independent variables. Other independent variables include hourly wage rate, other weekly income, age, demographic information, labor market variables such as part time job and employed, countywide monthly unemployment rate, county-level business and environmental factors, geographic locations, and time of the ATUS interview. The age, demographic, business and environmental factors, and family structure variables are included to control for opportunity cost of time, and the geographic information is included to control for the unobservable fixed effect. County of residences, year and month of interviews are added to control for seasonal and national trend. Other weekly income is used as a measure of wealth effect, which is defined by:  $[(\text{Annual family income}/52) - \text{weekly wage}]$ . When the variable other weekly income is created, missing values in weekly wage were replaced by zeros. Negative values of the variable other weekly income are replaced by zeros and for which a dummy variable is created.

The range of age is from 15-85 in the ATUS data. In this paper, individuals' age is restricted to at least 18 years old because these younger than 18 are out of labor market. Observations in which individuals are employed and weekly wage or work hours are missing are replaced by zeros. Blue/White collar workers are defined by their main occupations in the CPS data set. The demographic information includes variables of race, gender, marital status, and the number of children younger than 18 per household. All nominal variables including the hourly wage rate and other weekly income are deflated by the CPI.

The health outcome is measured by samples' self-reported health status (i.e., categorical variable from 1 to 5 with 5 indicating the excellent health). A dichotomous variable of health is generated for the self-reported health outcome which equals one if individuals report their health as very good or excellent; otherwise it equals zero. The education is measured by a categorical variable from 0 to 20 years of schooling. The low, intermediately and highly educated people are defined by a three-value categorical variable with which the low category is from 0 to 12 years, the intermediate category is from 13 to 16 years, and the high category is from 17 to 20 years.

The geographic location is defined by the county of residence with which the countywide monthly unemployment rate from Department of Labor is linked to the ATUS data set. The countywide monthly unemployment rate as well as other county-level variables serve as control variables in the probit models.

The leisure physical activity is defined by the summation of the time spent on each leisure activity (e.g., jogging, bowling, yoga, etc.) multiplied by the intensity of the corresponding activity (e.g., MET/hour). The value of leisure activity is reported by National Cancer Institute. One unit of MET is defined by the number of calories consumed by the designated leisure activity in proportion to the number of calories consumed by sitting quietly. For example, the MET value for walking is 2, and the MET value for sitting is 1. Based on the intensity for each activity, this paper calculated the average intensity using a weighted average function that has been described in Equation 4. For the intensity, a categorical variable is created with a value of 1 for the light-intensity LPA, a value of 2 for the moderate-intensity LPA and a value of 3 for the vigorous-intensity LPA. The moderate-intensity LPA refers to a leisure physical activity with approximately 3-6 METs, which means the energy that a person consumes

is equivalent to three to six times higher than sitting quietly when such activity is taken. The vigorous-intensity physical activity is a leisure physical activity with approximately 6 METs or above.

The leisure physical activity duration in the dataset is measured by the number of minutes spent on each leisure activities. This paper summed the time for 77 leisure activities and divided the total time in minutes by 60 to get the total duration in hours. A number of zeros are observed in leisure physical activity duration because the ATUS interview is conducted for leisure activities during 24 hours of the interview day.

## **2.4 Empirical Analysis**

### **2.4.1 Descriptive Statistics**

Tables 12 and 13 report the results of means for main variables in subsamples. Compared to the total ATUS data set, some subsamples may not have a given variable which may result in a sample selection bias. In Table 12, for example, the sample size for the sub sample with the county of residence and other county level business and environmental variables in column 1 is 30,759; The sample size for the sub sample with the self-reported health outcome and the county of residence in column 2 is 16,975; The sample size of the sub sample with the county of residence, other county level business and environmental variables, and the health outcome in column 3 is 11,270; The total ATUS sample size in column 4 is 124,517. To test the potential of sample selection bias, this paper compares the mean of each sub sample with the mean of the entire data set. The results showed that the sample selection bias does not exist. For example, with respect to the dichotomous variable health, the mean for the sub sample with the county of residence and environmental variables reported is 0.537, the mean for the sub sample with the

county of residence and health reported is 0.536, and the mean for the sub sample with the county of residence, environmental variables and health reported is 0.537. If one compares the mean for each sub sample with the mean of the entire data set (i.e., 0.534), the differences are no larger than 0.56%. However, it has been noted that for some variables there are slightly larger differences between the means of the sub sample with county level variables reported and the means of the entire data set. The mean of leisure physical activity intensity for the sub sample with the county of residence and health reported is 0.948 METs/hours. Compared with the mean of the LPA intensity for the entire data set (0.862 METs/hours), the difference is 9.98%. Differences between other sub samples and the entire data set have a close magnitude due to a large sample size reduce. Sub samples with the self-reported health outcome variable have a little difference in the means of almost all variables. For example, the sub sample with health reported with the county of residence and environmental variables and the sub sample with health reported with the county of residence have very close means (<1%) though their sample sizes are 11,270 and 16,975.

Table 13 shows the changes in the leisure physical activity duration (T), the leisure physical activity (LPA), and the average leisure intensity (I) over the entire period of 2003 – 2011. Only three years of the ATUS data (2006 – 2008) has the self-reported health outcome variable. To test potential selection bias on the LPA related variables in sub samples with and without the health variable, Table 13 reports that the means in the LPA, the LPA duration and the intensity are very close between sub samples with the health variable from 2006 to 2008 and sub samples without the health variable from 2003 to 2005 and from 2009 to 2011.

Table 14 demonstrates the differences in the means of the dichotomous health variable across different subgroups in the LPA intensity, the duration, the education, the hourly wage rate, the other weekly income, the age and the occupation (white/blue collar) in a sub sample from 2006 to 2008. For the leisure physical intensity, 50.6% of people who have a low intense LPA reported a very good or excellent health (VGEH) status. A moderate-intensity LPA increases the probability of a VGEH status from 50.6% to 61.6%. Individuals who have a vigorous LPA reported that 74% of them have VGEH status. As the LPA duration increases, people are healthier. People who spend time on a LPA below 80th percentile have a 50% of VGEH rate. Individuals who spend leisure time between 80th and 90th percentile have a VGEH rate of 64.2%. People whose leisure time in the upper 10th percentile have a highest VGEH rate of 66.6%. For education, the more educated people are healthier. On average, an individual with a high school diploma has a 40% chance to be VGEH while an individual who hold a graduate school diploma has a 71.7% change to be VGEH. As age increases, the chance of being VGEH increases until the category of 40 years old. After 40 years old, people become less healthy on average. For occupations, white collar workers are much healthier than blue collar workers by 13%. Near half of the blue workers think they are VGEH while 62% of the white collar workers reported they are VGEH. The patterns are similar for the hourly wage rate and the other weekly income. As the wage rate increases, the VGEH rate increases except for the first category. In the first category, 50.7% of people claimed VGEH. The VGEH rate drops to 46.3% in the second category and continuously increases in the following categories. In the most upper category, the VGEH rate is 74.1%. A similar pattern is observed for the other weekly income. For example, the VGEH rate drops first from 52.7% in the first category to 36.1% in the second category and

continuously increases to a peak at 74% in the most upper category. This means that 10% of people who have highest other weekly income are healthier than the other 90% of people.

#### 2.4.2 Multivariate Analysis

The empirical model is a reduced form health production function: the dichotomous health variable is a function of leisure physical activity intensity, duration, market goods and efficiency as expressed in Equation 15. It is hypothesized that the health stock increases as the leisure physical activity increases. Since the leisure physical activity is decomposed by the LPA intensity and the LPA duration, as their LPA intensity or duration increases, individuals produce more health with other variables constant. It is anticipated that this pattern may not be linear for the vigorous-intensity LPA population, as an over intense leisure physical activity may cause negative impacts on health by injury or fatigue.

$$H=H(T, I, \text{Other variables}), \quad (15)$$

Since H is the dichotomous variable, the production function of (15) can be estimated by a probit model. With the assumption of independent and normal distributed error terms, the probit model can be mathematically expressed by

$$P(H_i = 1 | x) = \Phi(x_i' \beta), \quad (16)$$

Where  $H_i$  is the self-reported health dummy variable, and  $x_i$  refers to independent variables such as the geographic location, the labor force variables, the demographic information, the county-level business (e.g. average price of tennis ball, number of recreational goods rental), environmental factors (e.g., weather condition, crime rate), and county monthly employment rate may be added to control the potential confounding relation between the health variable and the

LPA intensity or between the health variable and the LPA duration. Time (month and year) and location (county) fixed effects are considered in all models for unobserved fixed time and area effects. Standard errors are all adjusted for individuals residing in the same county and for the same month and year as interviewed.

The probit model in Equation 16 is estimated by the maximum likelihood method. The dichotomous self-reported health variable is used as the dependent variable because the probit model is easier to interpret than an ordered probit model as the original self-reported health variable is used as the dependent variable. A comparison between the results in the probit models and ordered probit models has been done while they are not reported in this paper. No significant difference has been observed in terms of signs of coefficients. It is also worth noting that a large number of zero LPA has been included in this essay, which may cause biased estimates. A dummy variable that equals one if LPA equals zero can be added in the above probit models. However, no significant difference in the results between the models with and without the above dummy is observed in terms of signs of coefficients.

Table 15 reports the average marginal effects at means for five probit models with every good or excellent health (VGEH) status as the dependent variable. In the first specification (baseline model), the independent variables are demographic variables (i.e., race, age, and gender), the LPA intensity and duration. In the second specification, in addition to the variables included in the first specification, the age, wage rate and labor force status variables are added. In the third specification, in addition to the independent variables included in the first specification, the efficiency and time constraint variables are added such as education, age squared, other weekly income, the number of children younger than 18 per household, and

marital status of the interviewee. The fourth specification includes all independent variables in the specification two, and county level business and environmental variables, countywide unemployment rate, part time job, and day of interview. The fifth specification covers all variables used in the fourth specifications. Compared to the original ATUS and CPS dataset, the sample sizes of all five specifications are smaller, because the country level variables and self-reported health variable are only available for three years and not for all individuals. In the larger dataset, the number of observations is 16,101. However, only 10,633 observations also have county level environmental information. The following paragraphs will report the results of the five specifications.

In the first specification, the probability of reporting a VGEH by Asians is 7.1 percentage points, by Blacks is 16.6 percentage points, by the Hispanics is 21.4 percentage points and by the other race is 8.6 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level except for the other race. With regarding with gender, males have a lower probability of reporting a VGEH by less than 0.1 percentage points than females. This effect is statistically significant. On average, one more MET/hours in the leisure physical activity intensity contributes a higher probability of reporting a VGEH by 2.6 percentage points. This effect is statistically significant at one percent significant level. One hour spent on leisure physical activity may increase the probability of reporting VGEH by 0.9 percentage points while it is not statistically significant.

In the second specification, after adding the age, wage rate and employment status, the impact of races on the probability of reporting a VGEH remains significant. However, magnitudes of these effects are larger compared to those in the first specification. The probability

of reporting a VGEH by Asians increases to 11.8 percentage points, by the Hispanics increases to 24.5 percentage points and by the other race rises to 10.9 percentage points, which are lower than Whites. Blacks remain the same. The gender effect on a VGEH increases dramatically. Males have a statistically significantly lower probability of reporting a VGEH by 3.8 percentage points than females. The effects of the LPA intensity and duration do not change. For age, one more year contributes a 0.4 percentage points less chance to report a VGEH. Employed people have a 13.1 percentage points higher chance to report a VGEH than the unemployed. For individuals who are employed, one dollar raise in the hourly wage rate increases the probability of reporting a VGEH by 0.4 percentage points.

The third specification added the time constraints, education and age squared variables on the second specification. The results suggest that the addition of these variables results in some changes in the coefficients of the variables that are included in the second specification. The race effects remain statistically significant and negative in signs. Asians become less likely to report a VGEH than Whites by a probability of 14.3 percentage points. The probability of reporting a VGEH by Blacks decreases to 11.3 percentage points which is lower than Whites. The probability drops to 14.3 percentage points for Hispanics which is lower than Whites. The probability of reporting a VGEH contributed by the LPA intensity with other variables constant drops by 0.5 percentage points, a little from the second specification. The addition of quadratic term of the age has a statistically significant impact on the probability of reporting a VGEH and the first order age effect increases to 1 percentage points in an absolutely value of the probability which means that the age effect is in a quadratic shape, which is supported by the descriptive statistics in Table 14. For education, one more year of schooling leads to a higher probability of reporting a VGEH by 3.4 percentage points. The other weekly income has a very small positive

and statistically significant impact on the probability of reporting a VGEH. The number of children drops the probability by 0.4 percentage points and married people are more likely to report a VGEH by a higher chance of 1.9 percentage points.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, county level business and environmental variables on the third specification. The racial effects on the probability of reporting a VGEH rise in absolute values except for Asians. For the added variables, people who have a part time job less likely report a VGEH with a smaller chance of 4.2 percentage points. Other covariates are not statistically significant.

The fifth specification is the full model which includes all the variables that have been used in the previous four specifications. The results show that the addition of time constraints and county level variables results in some changes in the coefficients: (1) Blacks have a lower probability of reporting a VGEH dropping to 9.6 percentage points than Whites; (2) Hispanics are less likely to report a VGEH than Whites by 15.6 percentage points compared with 21.4 percentage points in the first specification; (3) the impact of LPA intensity on the probability of reporting a VGEH decreases largely to 1.6 percentage points compared to 2.6 percentage points in the first specification. This full model has the highest Pseudo R2.

Tables 16 - 18 report the average marginal effects at means for five probit regression models for sub samples with three levels of school education. The dependent variable is the probability of reporting a VGEH and the independent variables for all five specifications are the same as those in the five specifications reported in Table 15.

In Table 16, the sub sample is restricted to individuals who have a maximum of 12 years of schooling. The sample size decreases to 6,067 without the county level variables and to 3,992 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 8.2 percentage points, by Blacks is 13.4 percentage points, by the Hispanics is 16.8 percentage points and by the other race is 2.5 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level except for Asians and other race. Racial differentials in the health outcome are smaller than those in Table 15. With regarding with gender, males have a statistically significantly higher probability of reporting a VGEH by 4.9 percentage points than females compared to a negative impact in the entire sample. This means that intermediately educated males are more likely to report a higher probability of a VGEH than females. On average, one more MET/hours in the leisure physical activity intensity contributes a higher probability of reporting a VGEH by 1.5 percentage points, which is lower than that in the entire sample. This effect is statistically significant at one percent significant level. One more hour spent on the leisure physical activity may increase the probability of reporting a VGEH by 0.7 percentage points while it is not statistically significant.

In the second specification, after adding the variable age, wage and employment status, the impact of races on the probability of reporting a VGEH remains significant. However, magnitudes of these effects are larger compared to those in the first specification. The probability of reporting a VGEH by Asians increases to 11.4 percentage points, by the Hispanics rises to 21.5 percentage points and by the other race is to 5.4 percentage points, which are lower than Whites. Blacks remains the same. The gender effect on the health outcome decreases dramatically. Males have a statistically insignificantly higher probability of reporting a VGEH by 0.4 percentage points than females. The effects of the LPA intensity and duration change a

little. For age, one more year contributes a less chance of 0.4 percentage points to report a VGEH. Employed people have a higher chance of 15.5 percentage points to report a VGEH than the unemployed. The wage effect is not statistically significant.

The third specification added the time constraints, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in some change in the coefficients of the variables that are included in the second specification. The racial impacts decrease. Asians become less likely to report a VGEH than Whites by a chance of 9.4 percentage points. The probability of reporting a VGEH by Blacks decreases to 11.3 percentage points, which are lower than Whites. The probability drops to 15.2 percentage points for Hispanics which is lower than Whites. The probability contributed by the LPA intensity with other variables constant drops slightly by 0.3 percentage points from the second specification. The addition of the quadratic term of age has a statistically significant impact on the probability of reporting a VGEH and the age effect increases to 1.2 percentage points in an absolute value on the probability. For education, one more year of schooling increases the probability of reporting a VGEH by 2.3 percentage points. The other weekly income has a very small positive but statistically significant impact on the probability of reporting a VGEH. The number of children decreases the probability of reporting a VGEH by 0.2 percentage points.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables but added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 3,992. The racial effects on the probability of reporting a

VGEH rise in absolute values. For the added variables, their coefficients are not statistically significant.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of time constraints and county level variables results in a little change in the coefficients: (1) Blacks have a lower probability of reporting a VGEH dropping to 9.3 percentage points than Whites; (2) Hispanics are less likely to report a VGEH than Whites by 18.5 percentage points; (3) the impact of the LPA intensity on the probability to report a VGEH is not statistically significant compared to a chance of 1.5 percentage points in the first specification. This full model has the highest Pseudo R2.

Table 17 reports the results for the sub sample which is restricted to individuals who have 12- 16 years of schooling. The sample size is 7,937 without the county level variables and 5,193 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 14.5 percentage points, by Blacks is 13.5 percentage points, by the Hispanics is 10.6 percentage points and by the other race is 12.1 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level. For gender, males have a lower statistically significantly probability of reporting a VGEH by 2.9 percentage points than females. This means that the low educated males are less likely to report a VGEH than females. On average, one more MET/hours in the leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 2.4 percentage points. This effect is statistically significant at one percent significant level. One more hour spent on leisure physical activity may increase the probability of reporting a VGEH by 0.8 percentage points though it is not statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of races on the probability of reporting a VGEH remains significant. However, magnitudes of these effects are larger compared to those in the first specification. The probability of reporting a VGEH by Asians increases to 17.6 percentage points, by the Hispanics rises to 14.5 percentage points and by the other race is to 14.6 percentage points, which are lower than Whites. Blacks remains the same. The effect of gender on the health outcome rises dramatically in an absolute value. Males have a statistically significantly lower probability of reporting a VGEH by 5.3 percentage points than females. The effects of the LPA intensity and duration change little. For age, one more year contributes to a less chance of 0.4 percentage points to report a VGEH. Employed people have a higher chance of 7.8 percentage points to report a VGEH than the unemployed. The wage effect is small and statistically significant.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in small changes in the coefficients of the variables that are included in the second specification. The racial impacts decrease except for Asians. Asians become less likely to report a VGEH than Whites by a chance of 18.4 percentage points. The probability of reporting a VGEH by Blacks increases to 9.6 percentage points which is lower than Whites. The probability of reporting a VGEH is 12 percentage points for Hispanics which is lower than Whites. The probability contributed by the LPA intensity with other variables constant remains the same. The addition of the quadratic term of age has a statistically significant impact on the probability of reporting a VGEH and the age effect increases to 1 percentage points in an absolutely value on the probability. For education, one more year of schooling increases a higher probability of reporting

a VGEH by 2.8 percentage points. Other weekly income has a very small positive and statistically significant impact on the probability of reporting a VGEH.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 5,193. The racial effects on the probability of reporting a VGEH rise in absolute values except for the other race. For the added variables, their coefficients are not statistically significant except for a negative holiday effect and a small positive temperature squared effect.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of time constraints and county level variables results in some changes in the coefficients: (1) Blacks have a lower probability of reporting a VGEH dropping to 7.4 percentage points compared to 13.5 percentage points than Whites in the first specification; (2) the full model has the highest Pseudo R2; (3) Married people have a higher probability of reporting a VGEH by 3.5 percentage points; (4) a part time job decreases the probability of reporting a VGEH by 6.2 percentage points.

Table 18 reports the results for the sub sample which is restricted to individuals who have a minimum of 17 years of schooling. The sample size is 1,784 without the county level variables and 1,032 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 6.6 percentage points, by Blacks is 19.6 percentage points, by the Hispanics is 4 percentage points and by the other race is 8.6 percentage points, which are lower than Whites. All estimates are statistically insignificant except for Blacks. For gender, males have a

statistically significantly lower probability of reporting a VGEH by 5.5 percentage points than females. This means that the highly educated males are more likely to report a lower probability of a VGEH than females. On average, one more MET/hours in the leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 0.6 percentage points. This intensity effect on the health outcome is small and it is statistically insignificant. One more hour spent on the leisure physical activity may increase the probability of reporting a VGEH by 3.8 percentage points and it is statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of Asians on the probability of reporting a VGEH becomes statistically significant and doubled in value. The probability of reporting a VGEH by Asians increases to 12.4 percentage points and by the other race is to 8.5 percentage points, which are lower than Whites. Blacks and Hispanics effects remain statistically insignificant. The gender effect on the health outcome changes a little. Males have a statistically significantly lower probability of reporting a VGEH by 4.8 percentage points than females. The effects of the LPA intensity and duration change a little. For age, one more year contributes to a less chance of 0.6 percentage points to report a VGEH. The employed and wage effects are statistically insignificant.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in no change in the coefficients of the variables that are included in the second specification. The probability contributed by the LPA intensity with other variables constant remains the same. The addition of the quadratic term of age and education has statistically insignificant impact on the

probability of reporting a VGEH. The other weekly income has a very small positive (0.00008) and statistically significant impact on the probability of reporting a VGEH.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 1,032. The racial effects on the probability of reporting a VGEH decrease in absolute values except for Blacks. Employed people have a higher chance of 11.9 percentage points to report a VGEH. For the added environmental variables, their coefficients are not statistically significant except for the pedestrian fatality, sports rental and density. For people who are highly educated, who have less intense LPA, and who live in a place with lower pedestrian fatality, more sports rental stores and less population density increase the probability of reporting a VGEH. For example, every opened sport rental store per 1000 capita contributes to a 97 times higher chance to report a VGEH and every pedestrian fatality per 1000 capita decreases the probability of reporting a VGEH by 12 times.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of the time constraints and county level variables results in little change in the coefficients compared to the previous four specifications.

To investigate the LPA intensity and duration impacts on the health outcome across sub samples with different intensity leisure physical activities, I fit probit models for three sub samples with light-intensity LPA, moderate-intensity LPA and vigorous-intensity LPA respectively. Tables 19 - 21 report the average marginal effects at means for five specifications

for sub samples with such three intensity levels. The dependent variable is the probability of reporting a VGEH and the independent variables for all five specifications are the same as the five specifications reported in Table 15.

In Table 19, the sub sample is restricted to individuals who have light-intensity leisure physical activities. The sample size decreases to 13,707 without the county level variables and to 9,033 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 4.9 percentage points, by Blacks is 15.2 percentage points, by the Hispanics is 20.2 percentage points and by the other race is 7.7 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level except for Asians and the other race. Racial differentials in the health outcome are smaller than those in Table 15. For gender, males have a statistically insignificantly higher probability of reporting a VGEH by 0.9 percentage points than females compared to a negative impact in the entire sample. On average, one more MET/hours in leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 9.2 percentage points, which is much higher than that in the entire sample. This intensity effect on the health outcome is statistically significant at one percent significant level. One hour spent on leisure physical activity may increase the probability of reporting a VGEH by 0.8 percentage points and it is not statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of race on the probability of reporting a VGEH remains negative and statistically significant. However, magnitudes of these effects are larger compared to those in the first specification. The probability of reporting a VGEH by Asians increases to 9.7 percentage points, by the Hispanics rises to 23.4 percentage points and by the other race is to 9.9 percentage points, which are lower

than Whites. Blacks remains the same. The gender effect on the health outcome increases dramatically and becomes significant. Males have a lower probability of reporting a VGEH by 3.1 percentage points than females. The effects of the LPA intensity and duration change a little. For age, one more year contributes to a lower chance of 0.4 percentage points to report a VGEH. Employed people have a higher chance of 13.4 percentage points to report a VGEH than the unemployed. The wage effect is 0.5 percentage points and statistically significant.

The third specification added the time constraints, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in some changes in the coefficients of the variables that are included in the second specification. The racial impacts decrease. Asians become less likely to report a VGEH than Whites by a chance of 11.9 percentage points. The probability of reporting a VGEH by Blacks decreases to 10 percentage points which is lower than Whites. The probability drops to 13.6 percentage points for Hispanics which is lower than Whites. The probability of reporting a VGEH contributed by the LPA intensity with other variables constant drops slightly by 1.5 percentage points from the second specification. The addition of the quadratic term of age has a statistically significant impact on the probability of reporting a VGEH and the age effect increases to 1 percentage points in an absolute value. For education, one more year of schooling increases the probability of reporting a VGEH by 3.3 percentage points. Other weekly income has a very small positive and statistically significant impact on the probability of reporting a VGEH. Married people have a higher probability by 2.1 percentage points.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews,

countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 9,033. The racial effects on the probability of reporting a VGEH rise in absolute values except for Asians. The coefficient of the other race becomes statistically insignificant. The impact of the LPA intensity increases while the impact of the LPA duration becomes negative in value. For the added variables, their coefficients are not statistically significant. The wage and employed individuals have positive impacts on the health outcome.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of the time constraints and county level variables results in some changes in the coefficients: (1) Blacks have a lower probability of reporting a VGEH dropping to 8.9 percentage points than Whites; (2) Hispanics are less likely to report a VGEH than Whites by 14.6 percentage points; (3) Asians have the probability of reporting a VGEH by 11.9 percentage points less than Whites; (4) the impact of having a part time job has a lower probability of reporting a VGEH by 4.1 percentage points. This effect is statistically significant; (5) This full model has the highest Pseudo R2.

Table 20 reports the results for the sub sample which is restricted to individuals who have moderate-intensity LPAs. The sample size is 1,628 without the county level variables and 1,026 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 21.8 percentage points, by Blacks is 29.4 percentage points, by the Hispanics is 27.2 percentage points and by the other race is 15.5 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level except for the other race. For gender, males have a statistically insignificantly lower probability of reporting a VGEH

by 4.2 percentage points than females. This means that the moderate active males are less likely to report the probability of a VGEH than females. On average, one more MET/hours in the leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 5.2 percentage points. This effect is statistically significant at one percent significant level. One hour spent on leisure physical activity may increase the probability of reporting a VGEH by 0.8 percentage points though it is not statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of race on the probability of reporting a VGEH remains significant. However, magnitudes of these effects are larger compared to those in the first specification. The probability of reporting a VGEH by Asians increases to 26.9 percentage points, by the Hispanics rises to 31.1 percentage points and by the other race is to 19 percentage points, which are lower than Whites. Blacks remains the same. The gender effect on the health outcome increases dramatically. Males have a statistically significantly lower probability of reporting a VGEH by 6.5 percentage points than females. The effect of the LPA intensity and duration becomes insignificant and smaller than that in the first specification. For age, one more year contributes to a lower chance of 0.5 percentage points to report a VGEH. Employed people have a higher chance of 11.1 percentage points to report a VGEH than the unemployed. The wage effect is small and statistically insignificant.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in a little change in the coefficients of the variables that are included in the second specification. The racial impacts decrease except for Asians and the other race. Asians become less likely to report a VGEH than Whites by a chance of 31.9 percentage points. The probability of reporting a

VGEH by Blacks decreases to 25 percentage points which is lower than Whites. The probability is 18 percentage points for Hispanics which is lower than Whites. The probability contributed by the LPA intensity with other variables constant remains insignificant. The addition of the quadratic term of age has no impact on the probability of reporting a VGEH. For education, one more year of schooling results in a higher probability of reporting a VGEH by 4.4 percentage points. The other weekly income has a very small positive and statistically significant impact on the probability of reporting a VGEH.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 1,026. The racial effects on the probability of reporting a VGEH rise in absolute values except for the other race. For the added variables, their coefficients are not statistically significant except for the small negative impacts of the variables density and holiday.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of the time constraints and county level variables results in some changes in the coefficients: (1) the impact of the LPA duration increases to 2.5 percentage points and statistically significant; (2) the full model has the highest Pseudo R<sup>2</sup>; (3) the impact of having a part time job decreases the probability of reporting a VGEH by 12.5 percentage points.

Table 21 reports the results for the sub sample which is restricted to individuals who have vigorous-intensity LPAs. The sample size is down to 424 without the county level variables and

245 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 39.2 percentage points, by Blacks is 32.2 percentage points, by the Hispanics is 40.7 percentage points and by the other race is 14.7 percentage points, which are lower than Whites. All estimates are statistically insignificant except for the other race. For gender, males have a statistically insignificant lower probability of reporting a VGEH by 9.4 percentage points than females. On average, one more MET/hours in the leisure physical activity intensity contributes to a lower probability of reporting a VGEH by 15.1 percentage points. This means an over-intense exercise may lead to an adverse health outcome.

In the second specification, after adding the age, wage and employment status, the impact of Asians on the probability of reporting a VGEH becomes larger in an absolute value. The probability of reporting a VGEH by Asians is 43.8 percentage points which is lower than Whites. The other race remains statistically insignificant. The gender effect on the health outcome becomes statistically significant. Males have a statistically significantly lower probability of reporting a VGEH by 11.7 percentage points than females. The effects of the LPA intensity and duration change a little. The wage effect is 1 percentage points and statistically insignificant.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in some changes in the coefficients of the variables that are included in the second specification. The probability contributed by the LPA intensity with other variables constant remains the same. Blacks have no statistically significant impact on the health outcome. The addition of the quadratic term of age has a statistically insignificant impact on the probability of reporting a VGEH. One year of schooling contributes to a higher chance of 4.7 percentage points to report a

VGEH. The other weekly income has a very small positive and statistically significant impact on the probability of reporting a VGEH. One more child in a household decreases the probability by 5.6 percentage points.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 245. The racial effects on the probability of reporting a VGEH increase in absolute values except for Blacks and the other race. Males have a larger chance of 18.4 percentage points to report a VGEH. For the added environmental variables, their coefficients are not statistically significant. For the vigorous-intensity LPA population, the less intense LPA and higher wage rate may increase the probability of reporting a VGEH. For example, one dollar rise in the hourly wage rate increases the probability of reporting a VGEH by 1.3 percentage points.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of the time constraints and county level variables results in some changes in the coefficients compared to the previous four specifications. For environmental variables, the precipitation has a negative impact on the health outcome. Married individuals and the education have positive impacts however the holiday and number of child have negative impacts on the probability of reporting a VGEH.

For people who have different jobs, the LPA intensity and duration may have different impacts on the health outcome because the effects of job related physical activities are different. For example, a construction worker may demand a less intense LPA than an executive manager

because the former consumes much more energy in his or her job than the latter. Tables 22 – 23 report the average marginal effects at means for the LPA intensity and duration effects on the health outcome for individuals who are in labor market (with positive wage) and whose main occupations classified in either blue-collar or white-collar.

In Table 22, the sub sample is restricted to individuals who have blue-collar jobs. The sample size decreases to 1,371 without the county level variables and to 852 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 18.2 percentage points, by Blacks is 8.4 percentage points, by the Hispanics is 28.2 percentage points and by the other race is 26.2 percentage points, which are lower than Whites. All estimates are statistically significant except for Asians and Blacks. Racial differentials in the health outcome are smaller than those in Table 15. For gender, males have a statistically insignificantly higher probability of reporting a VGEH by 5.6 percentage points than females compared to a negative impact in the entire sample. On average, one more MET/hours in the leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 2.2 percentage points. This effect is statistically insignificant. One more hour spent on the leisure physical activity may increase the probability of reporting a VGEH by 2.2 percentage points and it is also not statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of race on the probability of reporting a VGEH remains negative. However, magnitudes of these effects are smaller compared to those in the first specification. The probability of reporting a VGEH by Asians decreases to 16.1 percentage points, by the Hispanics rises to 26.7 percentage points and by Blacks is to 6.8 percentage points, which are lower than Whites. The other race

remains the same probability. The gender effect on the health outcome decreases dramatically. Males have a higher probability of reporting a VGEH by 2.8 percentage points than females. The effects of the LPA intensity and duration change a little. For age, one more year contributes to a lower chance of 0.4 percentage points to report VGEH. One more dollar in the hourly wage rate may contribute to a higher chance of 1.1 percentage points of reporting a VGEH.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in little change in the coefficients of the variables that are included in the second specification. Hispanics become less likely to report a VGEH than Whites by a chance of 20.1 percentage points. The addition of the quadratic term of age has no statistically significant impact on the probability of reporting a VGEH. For education, one more year in schooling increases the probability of reporting a VGEH by 3.5 percentage points. Other coefficients are not statistically significant.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables but added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 852. Asians have a statistically significant lower probability of reporting a VGEH than Whites by 28.2 percentage points. The probability is up to 37.9 percentage points for Hispanics compared to Whites. The coefficient of other race becomes statistically insignificant. The impact of the LPA intensity increases while the impact of the LPA duration becomes negative and both coefficients are statistically insignificant. For the added

variables, their coefficients are not statistically significant. The wage has a positive impact on the health outcome but the age has a negative impact on the health outcome.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results suggest that the addition of the time constraints and county level variables results in no change in the coefficients. This full model has the highest Pseudo R2.

Table 23 reports the results for the sub sample which is restricted to individuals who have white collar jobs. The sample size is 7,452 without the county level variables and 4,844 with the county level variables. In the first specification, the probability of reporting a VGEH by Asians is 8.5 percentage points, by Blacks is 13.3 percentage points, by the Hispanics is 19.5 percentage points and by the other race is 12 percentage points, which are lower than Whites. All estimates are statistically significant at one percent significance level except for the other race. For gender, males have a statistically insignificantly higher probability of reporting a VGEH by 0.3 percentage points than females. On average, one more MET/hours in the leisure physical activity intensity contributes to a higher probability of reporting a VGEH by 2.4 percentage points. This effect is statistically significant at one percent significant level. One hour spent on the leisure physical activity may increase the probability of reporting a VGEH by 0.6 percentage points though it is not statistically significant.

In the second specification, after adding the age, wage and employment status, the impact of race on the probability of reporting a VGEH remains the same and significant. The probability of reporting a VGEH by Asians increases to 9.9 percentage points, by Hispanics is 18.9 percentage points, by Blacks is 11.9 percentage points and by the other race is to 12.3 percentage

points, which are lower than Whites. The gender effect on the health outcome becomes negative. Males have a statistically insignificantly lower probability of reporting a VGEH by 1.4 percentage points than females. The effects of the LPA intensity and duration remain the same as those in the first specification. For age, one more year contributes to a lower chance of 0.3 percentage points to report a VGEH. The wage effect is statistically significant by 0.6 percentage points.

The third specification added the time constraints variables, education and quadratic term of age on the second specification. The results suggest that the addition of these variables results in a little change in the coefficients of the variables that are included in the second specification. The racial impacts decrease except for Asians. Asians are less likely to report a VGEH than Whites by a chance of 13.2 percentage points. The probability of reporting a VGEH by Blacks decreases to 9.4 percentage points which is lower than Whites. The probability is 12.6 percentage points for Hispanics which is lower than Whites. The probability contributed by the LPA intensity with other variables constant remains the same. The addition of the quadratic term of age has no impact on the probability of reporting a VGEH. For education, one more year of schooling results in a higher probability of reporting a VGEH by 3.2 percentage points. The wage and other weekly income have small positive and statistically significant impacts on the probability of reporting a VGEH.

The fourth specification deleted the quadratic term of age, education, other weekly income and family structure variables and added the part time job, date of interviews, countywide unemployment rate, and county level business and environmental variables on the third specification. The sample size drops to 4,844. The effect of the LPA duration becomes

negative. The racial effects on the probability of reporting a VGEH rise in absolute values except for Asians. For the added variables, their coefficients are not statistically significant except for the part time job. Individuals who have part time jobs are less likely to report a VGEH by a chance of 4.6 percentage points.

The fifth specification is the full model with all the variables that have been used in the previous four specifications. The results show that the addition of time constraints and county level variables results in little change in the coefficients. The racial impacts on the health outcome decrease in absolute values except for Asians.

## **2.5 Conclusion**

The leisure physical activity is an important determinant of health. An individual would choose different types of exercises in terms of different durations and intensities to fulfill her or his personal health goal given the time opportunity cost and other constraints such as local environmental factors. For example, a high local crime rate may prevent individuals from the out of door exercises. Lack of sports facilities in local communities may be inconvenient for people to pursue leisure physical activities. Moreover, job related physical activities may influence the intensity level of leisure physical activities that people consume. White collar workers apparently have more intermediate to vigorous intensity LPA than blue collar workers because of relatively light job related physical activity. Therefore, it is reasonable to study the LPA intensity and duration as determinants of health across people in different job categories, education background and exercise behaviors.

This paper hypothesizes that (1) as the LPA intensity increases the health outcome increases; (2) as the LPA duration increases the health outcome is better; (3) the LPA intensity is

relatively more valuable than the LPA duration for a very good or excellent health outcome. The probit models are conducted to test these hypotheses with different specifications. The regression analyses in the full model (the fifth specification) indicate that the overall hypotheses of this paper are confirmed. The positive signs of the LPA intensity and duration coefficients in the regressions with a dichotomous health variable as the dependent variable suggest that more intense LPA or longer duration on LPA will lead to better health outcomes.

However, some results of the regression analyses are apart from the overall hypotheses. For example, the coefficient of the LPA intensity has a negative sign in the sub sample for an individual who hold a master's or above degree. One possible interpretation at this point is that the highly educated people may be more willing to choose low intensity exercises: they may prefer walking for one hour to lifting weights for a ten minute. The theoretical reasons are still not clear though it seems a common sense that on average highly educated people are less likely to choose intense exercise. The same pattern was observed for the sub sample for people who have the vigorous-intensity LPA. One potential explanation is that an over-intense LPA may have an adverse impact on health, which also means that the LPA duration is relatively more important for a very good or excellent health than the LPA intensity. On the contrary, for people who have high school degree or college degree, the benefit of LPA intensity on a very good or excellent health is more important than that of the LPA duration.

Common recommendations, such as walking for one hour a day, may not be adhered to by the low or intermediately educated people. However, physically more intense but time-wise less intense leisure physical activities are more likely to be adopted by this group. On the other hand, walking for one hour a day may be a good suggestion for the highly educated people since

they prefer time-wise more intense leisure physical activities to physically more intense leisure physical activities.

Table 1  
Descriptive Statistics: Means of main variables in four samples

Variable	Description	County and Environments	County	All ATUS
Health (Dummy)	=1 if self-reported health=4, 5 (very good or excellent)	0.537	0.536	0.534
BMI	Body mass index	26.893	26.925	27.132
Health	Self-reported health (1-5)	3.530	3.533	3.521
Leisure PA	PA in leisure	1.581	1.568	1.506
Leisure PA Intensity	Average Intensity on leisure PA	0.935	0.920	0.862
Leisure PA Duration	Total hours spent on leisure PA	0.338	0.339	0.331
Asian	Asian=1	0.045	0.046	0.032
Black	Black=1	0.119	0.121	0.115
Hispanic	Hispanic=1	0.185	0.191	0.135
Other Race	Other race =1	0.020	0.019	0.019
White	White=1	0.632	0.622	0.699
Male	Male=1	0.483	0.486	0.484
Age	Age	43.120	43.544	44.166
Education	Education	13.276	13.357	13.237
Family Income**	Annual family income (\$1,000)	31.044	30.450	29.002
Children	Number of household children <18	0.846	0.831	0.800
Married	Married	0.531	0.522	0.541
Part-time	Part time=1	0.144	0.143	0.143
Wage**	Hourly wage times employed. Missing wages are excluded.	9.951	9.904	9.349
Employed	Employed=1	0.650	0.636	0.638
Unemployed	Unemployed=1	0.050	0.064	0.059
Out of Labor	Not in labor force=1	0.299	0.300	0.303
Weekday	Weekday=1	0.711	0.712	0.714
Holiday	Holiday=1	0.018	0.017	0.017
Temperature	Average daily temperature*	58.282	58.388	58.390
Temperature Squared	Average daily temperature squared*	3643.951	3657.161	3657.276
Precipitation	Average daily precipitation*	2.973	2.974	2.975
Bowling Price**	Average price of bowling per year	1.984	1.984	1.984
Tennis Price**	Average price of tennis ball per year	1.252	1.232	1.232
Population	Population per square mile	3264.284	3225.602	3224.174
Other Income**	Other weekly income	379.378	375.429	357.658
Crime	Per 1000 capita number of crimes including arson per year	39.466	39.457	39.465
Sports Rental	Per 1000 capita number of recreational equipment rental stores	0.005	0.005	0.005
Pedestrian Fatalities	Per 1000 capita number of pedestrian fatalities per year	0.018	0.017	0.017
Unemployment Rate	Countywide monthly unemployment rate	5.094	6.861	6.861
Period		2003-2011	2003-2011	2003-2011
Sample size		30,758	54,377	124,517

Table 2

Means of LPA duration, LPA and LPA intensity in different groups of sampled individuals\*\*

Age (18-85 years)	Leisure PA Duration (hours)	Leisure PA (METs)	Leisure PA Intensity (METs/hour)
18-24	0.438	2.045	1.857
25-29	0.323	1.393	2.021
30-35	0.309	1.379	2.028
35-39	0.332	1.488	2.048
40-44	0.327	1.454	2.061
45-49	0.315	1.368	2.040
50-54	0.280	1.217	2.017
55-59	0.261	1.097	1.932
60-64	0.262	1.089	1.791
65-69	0.289	1.194	1.620
70-74	0.239	0.990	1.537
75-79	0.217	0.880	1.472
80-85	0.167	0.658	1.406
Total	0.300	1.308	1.903
Hourly Wage* (10 deciles)			
0 - \$3.41	0.241	1.052	2.133
\$3.42 - \$4.31	0.228	0.997	2.124
\$4.32 - \$5.23	0.229	0.989	2.153
\$5.24 - \$6.24	0.242	1.059	2.122
\$6.25 - \$7.41	0.275	1.210	2.123
\$7.42 - \$8.82	0.301	1.258	2.136
\$8.83 - \$10.54	0.343	1.469	2.131
\$10.55 - \$13.04	0.337	1.473	2.137
\$13.05 - \$17.64	0.379	1.709	2.137
\$17.65 - \$509.02	0.442	2.053	2.083
Total (100%)	0.310	1.366	2.127
*in real value			
**sampled individuals are restrict to 18 years old or older in the entire sample for 2003 - 2011			

Table 3  
 OLS estimates for leisure physical activity intensity as dependent variable (including exogenous variable LPA)

VARIABLES	(1) Intensity	(2) Intensity	(3) Intensity	(4) Intensity
Asian	-0.00955 (0.0415)	-0.00395 (0.0443)	-0.0218 (0.0568)	0.0150 (0.0627)
Black	-0.172*** (0.0251)	-0.130*** (0.0274)	-0.204*** (0.0345)	-0.163*** (0.0376)
Hispanic	-0.179*** (0.0248)	-0.113*** (0.0268)	-0.203*** (0.0325)	-0.128*** (0.0353)
Other Race	-0.124** (0.0620)	-0.0862 (0.0659)	-0.130* (0.0772)	-0.0911 (0.0800)
Male	-0.0596*** (0.0167)	-0.0696*** (0.0176)	-0.0743*** (0.0227)	-0.0761*** (0.0239)
Wage	0.00656*** (0.00137)	0.00450*** (0.00124)	0.00664*** (0.00189)	0.00538*** (0.00169)
Age	-0.000917 (0.000658)	-0.00199*** (0.000731)	-0.00113 (0.000911)	-0.00252** (0.00103)
Crime			-0.00422 (0.00396)	-0.00405 (0.00410)
Pedestrian Fatality			-0.0135 (2.139)	0.172 (2.319)
Sports Rental			-15.67** (7.127)	-17.79** (7.514)
Density			-1.48e-05 (0.000114)	-7.45e-06 (0.000139)
Temperature			0.000815 (0.00556)	0.00155 (0.00588)
Temperature Sq			1.27e-05 (6.34e-05)	-5.35e-06 (6.71e-05)
Precipitation			-0.0131 (0.0108)	-0.00855 (0.0115)
Part Time			-0.0430 (0.0305)	-0.00765 (0.0332)
Unemployment Rate			0.0272 (0.0205)	0.0253 (0.0218)
Leisure PA	0.303*** (0.00756)	0.299*** (0.00796)	0.306*** (0.00960)	0.303*** (0.0102)
Family Income		0.00441*** (0.000599)		0.00434*** (0.000836)
Children		-0.0266*** (0.00855)		-0.0355*** (0.0120)
Married		0.00526 (0.0202)		0.00180 (0.0277)
Constant	-0.221 (0.227)	-0.313 (0.285)	0.602* (0.351)	0.593 (0.370)
Observations	28,551	25,705	16,437	14,506
R-squared	0.501	0.501	0.503	0.505

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 4  
 OLS estimates for leisure physical activity duration as dependent variable (including exogenous variable LPA)

VARIABLES	(1) Duration	(2) Duration	(3) Duration	(4) Duration
Asian	-0.0285*** (0.00923)	-0.0297*** (0.00981)	-0.0257** (0.0128)	-0.0293** (0.0139)
Black	-0.0125* (0.00639)	-0.0127* (0.00721)	-0.00732 (0.00856)	-0.00623 (0.00966)
Hispanic	-0.0133** (0.00664)	-0.00859 (0.00691)	-0.00967 (0.00920)	-0.00288 (0.00941)
Other Race	-0.00149 (0.0193)	0.000715 (0.0212)	0.0122 (0.0209)	0.0200 (0.0226)
Male	0.0126*** (0.00435)	0.0140*** (0.00467)	0.00735 (0.00577)	0.0106* (0.00631)
Wage	0.000490* (0.000292)	0.000144 (0.000256)	0.000384 (0.000413)	-0.000154 (0.000328)
Age	7.65e-05 (0.000172)	0.000207 (0.000192)	0.000136 (0.000229)	0.000243 (0.000255)
Crime			-0.000806 (0.000829)	-0.000967 (0.000877)
Pedestrian Fatality			-1.015* (0.562)	-1.348** (0.597)
Sports Rental			3.415** (1.523)	3.568** (1.634)
Density			9.00e-06 (2.94e-05)	-6.89e-06 (3.79e-05)
Temperature			-0.000527 (0.00140)	-0.000550 (0.00146)
Temperature Sq			8.55e-06 (1.51e-05)	4.98e-06 (1.61e-05)
Precipitation			-0.000800 (0.00270)	-0.00134 (0.00272)
Part Time			-0.00762 (0.00770)	-0.00568 (0.00847)
Unemployment Rate			-0.0128** (0.00643)	-0.0142** (0.00698)
Leisure PA	0.195*** (0.00218)	0.195*** (0.00231)	0.195*** (0.00250)	0.196*** (0.00265)
Family Income		0.000362** (0.000158)		0.000399* (0.000209)
Children		-0.000563 (0.00225)		-0.000620 (0.00309)
Married		-0.0107** (0.00528)		-0.0102 (0.00677)
Constant	0.0540 (0.0452)	0.0711 (0.0651)	-0.0178 (0.0795)	0.000454 (0.0851)
Observations	28,551	25,705	16,437	14,506
R-squared	0.847	0.847	0.863	0.864

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 5  
 2SLS estimates in three baseline models (including endogenous variable LPA)

VARIABLES	(1) Duration	(2) Intensity
LPA	0.223*** (0.00761)	0.124*** (0.0339)
Asian	-0.0167 (0.0151)	-0.0862 (0.0687)
Black	0.00550 (0.00901)	-0.288*** (0.0422)
Hispanic	0.00255 (0.0104)	-0.282*** (0.0411)
Other Race	0.0309 (0.0223)	-0.225*** (0.0849)
Male	-0.0120 (0.00757)	0.0771** (0.0356)
Wage	-0.000341 (0.000451)	0.0108*** (0.00243)
Age	0.000673*** (0.000254)	-0.00458*** (0.00122)
Constant	-0.124* (0.0683)	0.753** (0.337)
Observations	16,437	16,437
R-squared	0.846	0.340

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage is in real value. In the first stage, dependent variable is LPA and exclusive instrumental variables are holiday, weekday, children, married, part time, county monthly unemployment rate, crime, pedestrian fatality, sports rental, density, temperature, temperature sq and precipitation.

Table 6  
 Probit models for positive leisure physical activity (LPA>0) as dependent variable

Dependant Variable	(1) Probability of LPA>0	(2) Probability of LPA>0	(3) Probability of LPA>0	(4) Probability of LPA>0
Wage	0.003*** (0.0004)	0.002*** (0.0003)	0.002*** (0.0005)	0.001*** (0.0004)
Asian (d)	-0.030** (0.0099)	-0.027* (0.0106)	-0.024 (0.0132)	-0.016 (0.0146)
Black (d)	-0.065*** (0.0065)	-0.055*** (0.0072)	-0.067*** (0.0085)	-0.057*** (0.0097)
Hispanic (d)	-0.062*** (0.0063)	-0.043*** (0.0069)	-0.065*** (0.0081)	-0.046*** (0.0091)
Other Race (d)	-0.032* (0.0160)	-0.022 (0.0176)	-0.032 (0.0203)	-0.022 (0.0225)
Male (d)	0.033*** (0.0047)	0.032*** (0.0048)	0.034*** (0.0061)	0.035*** (0.0064)
Age	-0.001*** (0.0002)	-0.001*** (0.0002)	-0.001*** (0.0003)	-0.001*** (0.0003)
Family Income		0.002*** (0.0002)		0.002*** (0.0002)
Children		-0.012*** (0.0025)		-0.014*** (0.0033)
Married (d)		-0.020*** (0.0055)		-0.022** (0.0074)
Crime			-0.001 (0.0010)	-0.001 (0.0010)
Pedestrian Fatality			-0.335 (0.5759)	0.026 (0.6327)
Sports Rental			-2.030 (1.6850)	-1.988 (1.7578)
Density			0.000 (0.0000)	0.000 (0.0000)
Temperature			0.003* (0.0014)	0.003 (0.0015)
Temperature Sq			-0.000 (0.0000)	-0.000 (0.0000)
Precipitation			-0.002 (0.0028)	-0.001 (0.0030)
Part Time			-0.007 (0.0080)	0.006 (0.0089)
Unemployment Rate			0.003 (0.0054)	0.004 (0.0058)
Constant				
N	28,478	25,593	16,300	14,362
R-squared	0.042	0.051	0.047	0.059

Marginal effects at means are calculated and reported in cells. Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is leisure that equals one if LPA duration is positive, otherwise zero. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 7  
 OLS estimates for leisure physical activity intensity as dependent variable conditional on positive LPA (including exogenous variable LPA)

VARIABLES	(1) Intensity	(2) Intensity	(3) Intensity	(4) Intensity
Asian	0.0721 (0.122)	0.114 (0.130)	0.0700 (0.155)	0.181 (0.171)
Black	-0.107 (0.106)	-0.0356 (0.117)	-0.144 (0.144)	-0.109 (0.161)
Hispanic	-0.115 (0.0848)	-0.0715 (0.0914)	-0.196* (0.115)	-0.177 (0.128)
Other Race	-0.637*** (0.189)	-0.645*** (0.198)	-0.716*** (0.268)	-0.797*** (0.276)
Male	-0.155*** (0.0544)	-0.182*** (0.0578)	-0.151** (0.0763)	-0.179** (0.0820)
Wage	0.000787 (0.00201)	2.70e-05 (0.00212)	0.00166 (0.00343)	0.00512 (0.00522)
Age	-0.00656*** (0.00216)	-0.00965*** (0.00243)	-0.00737** (0.00302)	-0.0100*** (0.00354)
Crime			0.00443 (0.0130)	0.00599 (0.0134)
Pedestrian Fatality			6.169 (7.433)	8.731 (7.925)
Sports Rental			-70.12*** (23.75)	-67.76*** (25.72)
Density			9.24e-05 (0.000307)	0.000239 (0.000418)
Temperature			0.0287 (0.0185)	0.0295 (0.0201)
Temperature Sq			-0.000355* (0.000197)	-0.000360* (0.000212)
Precipitation			-0.0437 (0.0332)	-0.0283 (0.0348)
Part Time			0.0455 (0.103)	0.0701 (0.115)
Unemployment Rate			0.199*** (0.0693)	0.176** (0.0736)
Leisure PA	0.0823*** (0.00369)	0.0812*** (0.00386)	0.0759*** (0.00487)	0.0738*** (0.00526)
Family Income		0.00243 (0.00169)		0.00117 (0.00247)
Children		-0.00622 (0.0305)		0.00426 (0.0426)
Married		0.223*** (0.0692)		0.161* (0.0972)
Constant	2.961*** (0.336)	2.315*** (0.211)	-0.248 (0.777)	-14.00 (29.05)
Observations	5,093	4,598	2,912	2,572
R-squared	0.182	0.192	0.213	0.225

Robust clustered standard errors for arbitrary correlation within county-year-month cells are reported in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 8  
 OLS estimates for leisure physical activity duration as dependent variable conditional on positive LPA (including exogenous variable LPA)

VARIABLES	(1) Duration	(2) Duration	(3) Duration	(4) Duration
Asian	-0.148*** (0.0439)	-0.166*** (0.0473)	-0.123** (0.0586)	-0.161** (0.0657)
Black	0.00592 (0.0446)	-0.0169 (0.0501)	0.0668 (0.0619)	0.0589 (0.0699)
Hispanic	-0.0177 (0.0399)	-0.0198 (0.0414)	0.0315 (0.0567)	0.0391 (0.0600)
Other Race	-0.00923 (0.0888)	-0.0257 (0.0959)	0.113 (0.102)	0.107 (0.110)
Male	0.0756*** (0.0244)	0.0868*** (0.0263)	0.0499 (0.0325)	0.0616* (0.0352)
Wage	9.19e-05 (0.000975)	-0.000538 (0.000900)	0.000197 (0.00155)	-0.00227 (0.00200)
Age	0.000384 (0.000977)	0.00165 (0.00107)	0.000527 (0.00133)	0.00147 (0.00146)
Crime			-0.000834 (0.00509)	-0.000921 (0.00529)
Pedestrian Fatality			-5.853* (3.207)	-7.387** (3.447)
Sports Rental			29.27*** (9.143)	28.05*** (9.858)
Density			7.86e-05 (0.000127)	2.11e-05 (0.000167)
Temperature			-0.0103 (0.00761)	-0.0125 (0.00824)
Temperature Sq			0.000112 (7.99e-05)	0.000111 (8.65e-05)
Precipitation			0.000858 (0.0141)	-0.00396 (0.0144)
Part Time			-0.000998 (0.0457)	0.00151 (0.0502)
Unemployment Rate			-0.0869** (0.0357)	-0.0844** (0.0377)
Leisure PA	0.172*** (0.00292)	0.173*** (0.00310)	0.175*** (0.00352)	0.176*** (0.00376)
Family Income		-9.72e-05 (0.000753)		0.000585 (0.00102)
Children		0.0117 (0.0134)		0.0128 (0.0189)
Married		-0.0571* (0.0309)		-0.0363 (0.0412)
Constant	0.895*** (0.246)	1.279*** (0.196)	2.428*** (0.351)	-0.183 (11.69)
Observations	5,093	4,598	2,912	2,572
R-squared	0.752	0.755	0.787	0.792

Robust clustered standard errors for arbitrary correlation within county-year-month cells are reported in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 9  
 OLS estimates for the ratio of LPA intensity to duration as dependent variable conditional on positive LPA  
 (including exogenous variable LPA)

VARIABLES	(1) Ratio	(2) Ratio	(3) Ratio	(4) Ratio
Asian	0.309 (0.378)	0.226 (0.406)	0.487 (0.421)	0.548 (0.445)
Black	0.0692 (0.341)	0.111 (0.375)	0.119 (0.364)	0.0847 (0.433)
Hispanic	-0.382 (0.343)	-0.526 (0.392)	0.0153 (0.294)	-0.162 (0.336)
Other Race	-1.111* (0.626)	-1.158 (0.711)	-1.003 (0.882)	-1.107 (0.982)
Male	-0.381 (0.247)	-0.346 (0.271)	-0.530*** (0.204)	-0.387* (0.222)
Wage	-0.0114*** (0.00438)	-0.0142** (0.00630)	-0.0104* (0.00569)	-0.0128 (0.0108)
Age	0.0106 (0.00760)	0.00955 (0.00795)	0.00773 (0.00811)	0.0148 (0.00943)
Crime			0.000289 (0.0316)	0.0126 (0.0331)
Pedestrian Fatality			17.71 (23.15)	12.50 (25.38)
Sports Rental			-69.86 (76.28)	-80.12 (78.14)
Density			0.000877 (0.000616)	0.00125 (0.000767)
Temperature			0.0488 (0.0473)	0.0822* (0.0499)
Temperature Sq			-0.000939* (0.000500)	-0.00123** (0.000530)
Precipitation			-0.0595 (0.0854)	-0.0410 (0.0919)
Part Time			-0.0364 (0.275)	0.0575 (0.306)
Unemployment Rate			0.469** (0.184)	0.463** (0.204)
Leisure PA	-0.254*** (0.0150)	-0.256*** (0.0166)	-0.255*** (0.0126)	-0.262*** (0.0140)
Family Income		-0.00873* (0.00491)		-0.0101 (0.00625)
Children		0.163 (0.149)		0.119 (0.116)
Married		0.753** (0.303)		0.378 (0.270)
Constant	5.961*** (1.572)	4.630* (2.622)	-2.387 (2.124)	-85.40 (53.59)
Observations	5,093	4,598	2,912	2,572
R-squared	0.105	0.107	0.256	0.267

Robust clustered standard errors for arbitrary correlation within county-year-month cells are reported in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage and Family Income are in real values.

Table 10  
 2SLS estimates in three baseline models conditional on positive LPA (including endogenous variable LPA)

VARIABLES	(1) Duration	(1) Intensity	(1) Ratio of Intensity to Duration
LPA	0.194*** (0.0269)	0.0946 (0.0578)	-0.497*** (0.137)
Asian	-0.318*** (0.0974)	0.510** (0.221)	0.680 (0.532)
Black	-1.050*** (0.308)	1.989*** (0.720)	1.734 (1.599)
Hispanic	-0.155* (0.0841)	0.0899 (0.176)	0.189 (0.455)
Other Race	-3.617*** (1.053)	7.606*** (2.497)	6.121 (5.202)
Male	0.668*** (0.211)	-1.407*** (0.488)	-0.650 (1.030)
Wage	-0.00716*** (0.00240)	0.0141*** (0.00513)	0.00794 (0.0112)
Age	0.00548** (0.00215)	-0.0105** (0.00457)	-0.0168 (0.0118)
Constant	0.606 (3.189)	8.082 (6.839)	1.639 (16.99)
Observations	2,912	2,912	2,912
R-squared	.	.	.

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. The omitted group in the independent variables is White. Wage is in real value. In the first stage, dependent variable is LPA and exclusive instrumental variables are holiday, weekday, children, married, part time, county monthly unemployment rate, crime, pedestrian fatality, sports rental, density, temperature, temperature sq, and precipitation.

Table 11  
2SLS estimates in three logarithmic baseline models conditional on positive LPA (including endogenous variable LPA)

VARIABLES	(1) ln(Duration)	(1) ln(Intensity)	(1) ln(Ratio of Intensity to Duration)
ln(LPA)	0.890*** (0.0625)	0.110* (0.0625)	-0.781*** (0.125)
Asian	-0.0449 (0.0372)	0.0449 (0.0372)	0.0897 (0.0745)
Black	-0.0268 (0.0742)	0.0268 (0.0742)	0.0535 (0.148)
Hispanic	0.0467 (0.0320)	-0.0467 (0.0320)	-0.0934 (0.0640)
Other Race	-1.775*** (0.514)	1.775*** (0.514)	3.549*** (1.029)
Male	-0.133*** (0.0388)	0.133*** (0.0388)	0.267*** (0.0776)
ln(Wage)	-0.0564*** (0.0216)	0.0564*** (0.0216)	0.113*** (0.0431)
Age	0.00747*** (0.00178)	-0.00747*** (0.00178)	-0.0149*** (0.00355)
Constant	-0.400 (1.136)	0.400 (1.136)	0.801 (2.272)
Observations	2,912	2,912	2,912
R-squared	.	.	.

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Three dependent variables, LPA, and wage are all in natural logarithmic form. The omitted group in the independent variables is White. Wage is in real value. In the first stage, dependent variable is logarithmic LPA and exclusive instrumental variables are holiday, weekday, children, married, part time, county monthly unemployment rate, crime, pedestrian fatality, sports rental, density, temperature, temperature squared, and precipitation.

Table 12  
Descriptive Statistics: Means of main variables in four samples

Variable	Description	County and Environments	County and Health	County, Health and Environments	All ATUS
Health (Dummy)	=1 if self-reported health=4, 5 (very good or excellent)	0.537	0.536	0.537	0.534
Health	Self-reported health (1-5)	3.530	3.533	3.530	3.521
Leisure PA	PA in leisure	1.581	1.654	1.631	1.506
Leisure PA Intensity	Average Intensity on leisure PA	0.935	0.948	0.936	0.862
Leisure PA Duration	Total hours spent on leisure PA	0.338	0.350	0.347	0.331
Asian	Asian=1	0.045	0.043	0.042	0.032
Black	Black=1	0.119	0.118	0.117	0.115
Hispanic	Hispanic=1	0.185	0.194	0.195	0.135
Other Race	Other race =1	0.020	0.022	0.022	0.019
White	White=1	0.632	0.623	0.624	0.699
Male	Male=1	0.483	0.487	0.486	0.484
Age	Age	43.120	43.639	43.421	44.166
Education	Education	13.276	13.313	13.279	13.237
Children	Number of household children <18	0.846	0.847	0.850	0.800
Married	Married	0.531	0.530	0.533	0.541
Part-time	Part time=1	0.144	0.142	0.142	0.143
Employed	Employed=1	0.650	0.651	0.652	0.638
Unemployed	Unemployed=1	0.050	0.051	0.046	0.059
Out of Labor	Not in labor force=1	0.299	0.298	0.303	0.303
Weekday	Weekday=1	0.711	0.712	0.712	0.714
Holiday	Holiday=1	0.018	0.019	0.019	0.017
Temperature	Average daily temperature*	58.282	58.443	58.545	58.390
Temperature Squared	Average daily temperature squared*	3643.951	3663.261	3676.113	3657.276
Precipitation	Average daily precipitation*	2.973	2.999	2.996	2.975
Bowling Price**	Average price of bowling per year	1.984	1.981	1.978	1.984
Tennis Price**	Average price of tennis ball per year	1.252	1.168	1.182	1.232
Population	Population per square mile	3264.284	3115.587	3124.067	3224.174
Other Income**	Other weekly income	379.378	377.944	382.920	357.658
Crime	Per 1000 capita number of crimes including arson per year	39.466	38.507	38.524	39.465
Sports Rental	Per 1000 capita number of recreational equipment rental stores	0.005	0.005	0.005	0.005
Pedestrian Fatalities	Per 1000 capita number of pedestrian fatalities per year	0.018	0.017	0.018	0.017
Unemployment Rate	Countywide monthly unemployment rate	5.094	5.086	4.617	6.861
Period		2003-2011	2006-2008	2006-2008	2003-2011
Sample size		30,758	16,975	11,270	124,517

\* monthly and county variation but no annual variation  
\*\* in real values

Table 13

Means of the leisure PA duration, leisure PA and leisure PA intensity over different years\*

	Leisure PA Duration (hours)	Leisure PA (METs)	Leisure PA Intensity (METs/hour)
2003 (16%)	0.309	1.317	1.926
2004 (11%)	0.290	1.275	1.897
2005 (10%)	0.298	1.339	1.907
<b>2006 (10%)</b>	<b>0.291</b>	<b>1.270</b>	<b>1.909</b>
<b>2007 (9%)</b>	<b>0.307</b>	<b>1.332</b>	<b>1.932</b>
<b>2008 (10%)</b>	<b>0.297</b>	<b>1.308</b>	<b>1.906</b>
2009 (10%)	0.297	1.305	1.869
2010 (10%)	0.299	1.307	1.891
2011 (10%)	0.311	1.315	1.882
Total (100%)	0.300	1.308	1.903

\*sampled individuals are restrict to 18 years old or older in the entire sample for 2003 - 2011

**Table 14**  
**Means of the dichotomous health variable in different subgroups of sampled individuals\***

	Health (=1 if very good or excellent is reported)		Health (=1 if very good or excellent is reported)
<b>LPA Intensity</b> (METs)		<b>LPA Duration</b> (percentiles)	
Low (0-3)	0.506	<80%	0.500
Moderate (3-6)	0.616	80% - 90%	0.642
Vigorous (>6)	0.740	90% - 100%	0.666
Total	0.526	Total (100%)	0.526
<b>Education</b> (0-20 years)		<b>Hourly Wage**</b> (percentiles)	
0-12	0.379	<10%	0.507
13-16	0.605	10% - 20%	0.463
17-20	0.717	20% - 30%	0.503
Total	0.526	30% - 40%	0.518
<b>Age</b> (18-85 years)		40% - 50%	0.567
18-24	0.584	50% - 60%	0.598
25-29	0.601	60% - 70%	0.629
30-35	0.602	70% - 80%	0.667
35-39	0.613	80% - 90%	0.695
40-44	0.600	90% - 100%	0.741
45-49	0.569	Total (100%)	0.599
50-54	0.531	<b>Other Weekly Income**</b> (percentiles)	
55-59	0.470	<10%	0.527
60-64	0.443	10% - 20%	0.361
65-69	0.417	20% - 30%	0.407
70-74	0.365	30% - 40%	0.478
75-79	0.329	40% - 50%	0.487
80-85	0.310	50% - 60%	0.562
Total	0.526	60% - 70%	0.574
<b>White/Blue Collar</b>		70% - 80%	0.602
Blue (20%)	0.490	80% - 90%	0.680
White (80%)	0.620	90% - 100%	0.740
Total (100%)	0.594	Total (100%)	0.528

\*sampled individuals are restrict to 18 years old or older in the sub sample with the self-reported health variable for 2006 - 2008

\*\*in real values

Table 15  
 Probit models for the LPA intensity and duration effects on the health outcome

Variables	Probability of very good or excellent health				
Asian	-0.071*** (0.0216)	-0.118*** (0.0219)	-0.143*** (0.0222)	-0.124*** (0.0274)	-0.150*** (0.0273)
Black	-0.166*** (0.0131)	-0.167*** (0.0132)	-0.113*** (0.0138)	-0.156*** (0.0163)	-0.096*** (0.0172)
Hispanic	-0.214*** (0.0122)	-0.245*** (0.0132)	-0.143*** (0.0135)	-0.265*** (0.0161)	-0.156*** (0.0170)
Other Race	-0.086** (0.0315)	-0.109*** (0.0320)	-0.085** (0.0324)	-0.096* (0.0404)	-0.079 (0.0404)
Male	-0.0003 (0.0083)	-0.038*** (0.0087)	-0.037*** (0.0089)	-0.041*** (0.0110)	-0.040*** (0.0113)
LPA Duration	0.009 (0.0057)	0.008 (0.0058)	0.009 (0.0058)	0.010 (0.0073)	0.010 (0.0074)
LPA Intensity	0.026*** (0.0028)	0.025*** (0.0029)	0.020*** (0.0029)	0.022*** (0.0036)	0.016*** (0.0036)
Age		-0.004*** (0.0003)	-0.010*** (0.0016)	-0.005*** (0.0003)	-0.010*** (0.0019)
Age Squared			0.00006*** (0.00002)		0.00006** (0.00002)
Employed		0.131*** (0.0118)	0.142*** (0.0119)	0.147*** (0.0155)	0.160*** (0.0154)
Wage*Employed		0.004*** (0.0008)	0.003*** (0.0008)	0.004*** (0.0010)	0.003** (0.0010)
Education			0.034*** (0.0017)		0.037*** (0.0021)
Other Weekly Income			0.0002*** (0.00001)		0.0002*** (0.00002)
Children			-0.004 (0.0044)		-0.006 (0.0054)
Married			0.019* (0.0097)		0.025* (0.0122)
Crime				0.001 (0.0036)	0.002 (0.0036)
Pedestrian Fatality				0.334 (1.3393)	0.734 (1.3604)
Sports Rental				2.266 (3.9818)	3.608 (4.0322)
Density				-0.00006 (0.0001)	-0.00006 (0.0001)
Temperature				0.001 (0.0027)	0.001 (0.0028)
Temperature Sq				0.00002 (0.00003)	0.00003 (0.00003)
Precipitation				-0.005 (0.0050)	-0.004 (0.0050)
Part Time				-0.042* (0.0169)	-0.051** (0.0174)
Holiday				-0.045 (0.0415)	-0.041 (0.0424)
Weekday				0.010 (0.0105)	0.012 (0.0107)
Unemployment Rate				0.020 (0.0121)	0.018 (0.0124)
Observations	16,101	16,101	16,101	10,633	10,633
Pseudo R2	0.059	0.100	0.132	0.113	0.147

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 16  
 Probit models for the LPA intensity and duration effects on health conditional on the low educated individuals

Variables	Probability of very good or excellent health				
Asian	-0.082 (0.0434)	-0.114** (0.0402)	-0.094* (0.0429)	-0.146** (0.0445)	-0.130** (0.0465)
Black	-0.134*** (0.0178)	-0.142*** (0.0176)	-0.113*** (0.0186)	-0.127*** (0.0222)	-0.093*** (0.0239)
Hispanic	-0.168*** (0.0175)	-0.215*** (0.0172)	-0.152*** (0.0196)	-0.246*** (0.0207)	-0.185*** (0.0241)
Other Race	-0.025 (0.0529)	-0.054 (0.0515)	-0.039 (0.0525)	-0.108 (0.0612)	-0.098 (0.0614)
Male	0.049*** (0.0133)	0.004 (0.0137)	0.004 (0.0137)	-0.001 (0.0175)	-0.005 (0.0176)
LPA Duration	0.007 (0.0086)	0.005 (0.0090)	0.005 (0.0091)	0.006 (0.0117)	0.006 (0.0121)
LPA Intensity	0.015** (0.0048)	0.017*** (0.0049)	0.014** (0.0050)	0.014* (0.0062)	0.012 (0.0063)
Age		-0.004*** (0.0004)	-0.012*** (0.0022)	-0.004*** (0.0005)	-0.014*** (0.0028)
Age Squared			0.0001*** (0.00002)		0.0001*** (0.00003)
Employed		0.155*** (0.0166)	0.176*** (0.0174)	0.156*** (0.0217)	0.185*** (0.0227)
Wage*Employed		0.001 (0.0015)	0.002 (0.0017)	0.001 (0.0017)	0.002 (0.0019)
Education			0.023*** (0.0035)		0.022*** (0.0043)
Other Weekly Income			0.0002*** (0.00003)		0.0002*** (0.00003)
Children			-0.002 (0.0065)		-0.007 (0.0081)
Married			0.013 (0.0147)		0.026 (0.0182)
Crime				0.005 (0.0059)	0.005 (0.0059)
Pedestrian Fatality				0.818 (2.0465)	0.680 (2.0657)
Sports Rental				2.309 (6.2128)	2.458 (6.2353)
Density				-0.0003 (0.0002)	-0.0003 (0.0002)
Temperature				0.007 (0.0041)	0.007 (0.0042)
Temperature Sq				-0.00004 (0.00005)	-0.00004 (0.00005)
Precipitation				0.006 (0.0076)	0.007 (0.0077)
Part Time				0.013 (0.0265)	-0.013 (0.0263)
Holiday				0.082 (0.0672)	0.082 (0.0663)
Weekday				0.009 (0.0167)	0.005 (0.0168)
Unemployment Rate				0.006 (0.0175)	0.005 (0.0180)
Observations	6,067	6,067	6,067	3,992	3,992
Pseudo R2	0.066	0.106	0.120	0.128	0.142

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses  
 \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 17  
 Probit models for the LPA intensity and duration effects on the health outcome conditional on the intermediately  
 educated individuals

Variables	Probability of very good or excellent health				
Asian	-0.145*** (0.0310)	-0.176*** (0.0312)	-0.184*** (0.0315)	-0.191*** (0.0392)	-0.200*** (0.0395)
Black	-0.135*** (0.0201)	-0.140*** (0.0201)	-0.096*** (0.0206)	-0.117*** (0.0251)	-0.074** (0.0258)
Hispanic	-0.106*** (0.0192)	-0.145*** (0.0199)	-0.120*** (0.0199)	-0.139*** (0.0246)	-0.115*** (0.0247)
Other Race	-0.121** (0.0425)	-0.146*** (0.0433)	-0.123** (0.0435)	-0.077 (0.0542)	-0.057 (0.0537)
Male	-0.029* (0.0118)	-0.053*** (0.0121)	-0.054*** (0.0123)	-0.051*** (0.0154)	-0.056*** (0.0155)
LPA Duration	0.008 (0.0081)	0.008 (0.0081)	0.007 (0.0081)	0.014 (0.0101)	0.013 (0.0103)
LPA Intensity	0.024*** (0.0038)	0.025*** (0.0039)	0.022*** (0.0039)	0.021*** (0.0050)	0.019*** (0.0050)
Age		-0.004*** (0.0004)	-0.010*** (0.0023)	-0.004*** (0.0005)	-0.011*** (0.0028)
Age Squared			0.00007** (0.00002)		0.00007* (0.00003)
Employed		0.078*** (0.0166)	0.104*** (0.0175)	0.095*** (0.0211)	0.129*** (0.0221)
Wage*Employed		0.004*** (0.0009)	0.005*** (0.0010)	0.003** (0.0011)	0.004*** (0.0012)
Education			0.028*** (0.0061)		0.027*** (0.0076)
Other Weekly Income			0.0002*** (0.00002)		0.0002*** (0.00002)
Children			-0.004 (0.0061)		-0.007 (0.0077)
Married			0.026 (0.0136)		0.035* (0.0171)
Crime				-0.0005 (0.0049)	-0.0003 (0.0049)
Pedestrian Fatality				1.978 (1.9697)	2.080 (1.9599)
Sports Rental				-1.960 (5.8498)	-1.025 (5.9007)
Density				-0.0003 (0.0002)	-0.00025 (0.0002)
Temperature				-0.003 (0.0035)	-0.003 (0.0035)
Temperature Sq				0.00008* (0.00004)	0.00009* (0.00004)
Precipitation				-0.009 (0.0065)	-0.009 (0.0065)
Part Time				-0.037 (0.0233)	-0.062* (0.0243)
Holiday				-0.138* (0.0625)	-0.130* (0.0637)
Weekday				0.003 (0.0144)	0.007 (0.0145)
Unemployment Rate				0.023 (0.0171)	0.022 (0.0172)
Observations	7.937	7.937	7.937	5.193	5.193
Pseudo R2	0.052	0.078	0.092	0.090	0.102

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 18  
 Probit models for the LPA intensity and duration effects on the health outcome conditional on the highly educated individuals

Variables	Probability of very good or excellent health				
Asian	-0.066 (0.0427)	-0.124** (0.0456)	-0.120** (0.0464)	-0.052 (0.0586)	-0.048 (0.0589)
Black	-0.196*** (0.0445)	-0.192*** (0.0449)	-0.176*** (0.0454)	-0.224*** (0.0629)	-0.209** (0.0643)
Hispanic	-0.040 (0.0474)	-0.062 (0.0498)	-0.056 (0.0501)	-0.037 (0.0671)	-0.046 (0.0697)
Other Race	-0.086 (0.1051)	-0.085 (0.1076)	-0.097 (0.1059)	-0.082 (0.1535)	-0.104 (0.1545)
Male	-0.055* (0.0236)	-0.048* (0.0239)	-0.053* (0.0245)	-0.020 (0.0332)	-0.026 (0.0344)
LPA Duration	0.038* (0.0154)	0.039* (0.0158)	0.036* (0.0153)	0.050* (0.0236)	0.048* (0.0233)
LPA Intensity	0.006 (0.0061)	0.004 (0.0063)	0.005 (0.0062)	-0.007 (0.0086)	-0.005 (0.0087)
Age		-0.006*** (0.0009)	0.002 (0.0060)	-0.007*** (0.0013)	0.005 (0.0083)
Age Squared			-0.00008 (0.0001)		-0.0001 (0.0001)
Employed		0.070 (0.0372)	0.059 (0.0392)	0.119* (0.0492)	0.102 (0.0541)
Wage*Employed		0.001 (0.0011)	0.002 (0.0013)	0.001 (0.0013)	0.002 (0.0015)
Education			0.025 (0.0131)		0.035* (0.0174)
Other Weekly Income			0.00008* (0.00003)		0.00007 (0.00005)
Children			-0.005 (0.0130)		-0.012 (0.0185)
Married			0.010 (0.0291)		0.001 (0.0415)
Crime				0.011 (0.0133)	0.012 (0.0133)
Pedestrian Fatality				-11.557* (5.2099)	-12.192* (5.2483)
Sports Rental				97.142*** (20.4871)	96.379*** (20.6138)
Density				0.001*** (0.0002)	0.001*** (0.0002)
Temperature				-0.003 (0.0088)	-0.002 (0.0088)
Temperature Sq				0.00001 (0.0001)	-0.000007 (0.0001)
Precipitation				0.005 (0.0157)	0.006 (0.0156)
Part Time				-0.061 (0.0565)	-0.079 (0.0600)
Holiday				0.033 (0.1110)	0.013 (0.1231)
Weekday				0.030 (0.0314)	0.032 (0.0314)
Unemployment Rate				-0.010 (0.0462)	-0.012 (0.0464)
Observations	1,784	1,784	1,784	1,032	1,032
Pseudo R2	0.097	0.130	0.136	0.181	0.189

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 19  
 Probit models for the LPA intensity and duration effects on the health outcome conditional on the light-intensity LPA

Variables	Probability of very good or excellent health				
Asian	-0.049*	-0.097***	-0.119***	-0.094**	-0.119***
	(0.0234)	(0.0238)	(0.0240)	(0.0305)	(0.0304)
Black	-0.152***	-0.153***	-0.100***	-0.147***	-0.089***
	(0.0135)	(0.0137)	(0.0145)	(0.0175)	(0.0183)
Hispanic	-0.202***	-0.234***	-0.136***	-0.251***	-0.146***
	(0.0130)	(0.0133)	(0.0145)	(0.0179)	(0.0185)
Other Race	-0.077*	-0.099**	-0.071*	-0.080	-0.062
	(0.0337)	(0.0340)	(0.0346)	(0.0434)	(0.0436)
Male	0.009	-0.031***	-0.030**	-0.033**	-0.032**
	(0.0090)	(0.0094)	(0.0096)	(0.0120)	(0.0122)
LPA Duration	0.008	0.001	0.001	-0.002	0.0005
	(0.0131)	(0.0136)	(0.0139)	(0.0177)	(0.0190)
LPA Intensity	0.092***	0.098***	0.083***	0.102***	0.084***
	(0.0138)	(0.0141)	(0.0144)	(0.0177)	(0.0184)
Age		-0.004***	-0.010***	-0.005***	-0.010***
		(0.0003)	(0.0017)	(0.0004)	(0.0021)
Age Squared			0.00007***		0.00006**
			(0.00002)		(0.00002)
Employed		0.134***	0.150***	0.152***	0.171***
		(0.0121)	(0.0126)	(0.0158)	(0.0165)
Wage*Employed		0.005***	0.004***	0.005***	0.003**
		(0.0008)	(0.0009)	(0.0010)	(0.0010)
Education			0.033***		0.036***
			(0.0019)		(0.0023)
Other Weekly Income			0.0002***		0.0002***
			(0.00002)		(0.00002)
Children			-0.001		-0.002
			(0.0047)		(0.0058)
Married			0.021*		0.023
			(0.0105)		(0.0133)
Crime				-0.00003	0.001
				(0.0039)	(0.0039)
Pedestrian Fatality				0.036	0.339
				(1.4529)	(1.4749)
Sports Rental				3.555	4.443
				(4.2632)	(4.3417)
Density				0.00004	0.00004
				(0.0001)	(0.0001)
Temperature				0.002	0.001
				(0.0029)	(0.0030)
Temperature Sq				0.00002	0.00003
				(0.00003)	(0.00003)
Precipitation				-0.004	-0.002
				(0.0053)	(0.0055)
Part Time				-0.032	-0.041*
				(0.0181)	(0.0187)
Holiday				-0.006	-0.008
				(0.0426)	(0.0441)
Weekday				0.007	0.011
				(0.0115)	(0.0117)
Unemployment Rate				0.019	0.018
				(0.0128)	(0.0132)
Observations	13,707	13,707	13,707	9,033	9,033
Pseudo R2	0.055	0.097	0.127	0.112	0.144

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 20  
 Probit models for the LPA intensity and duration effects on the health outcome conditional on the moderate-intensity LPA

Variables	Probability of very good or excellent health				
Asian	-0.218** (0.0667)	-0.269*** (0.0664)	-0.319*** (0.0651)	-0.337*** (0.0780)	-0.369*** (0.0763)
Black	-0.294*** (0.0463)	-0.304*** (0.0460)	-0.250*** (0.0502)	-0.299*** (0.0592)	-0.246*** (0.0662)
Hispanic	-0.272*** (0.0407)	-0.311*** (0.0405)	-0.180*** (0.0454)	-0.374*** (0.0481)	-0.241*** (0.0578)
Other Race	-0.155 (0.1250)	-0.190 (0.1287)	-0.230 (0.1262)	-0.192 (0.1888)	-0.232 (0.1910)
Male	-0.042 (0.0272)	-0.065* (0.0281)	-0.067* (0.0290)	-0.050 (0.0373)	-0.053 (0.0394)
LPA Duration	0.008 (0.0081)	0.006 (0.0082)	0.009 (0.0085)	0.019 (0.0109)	0.025* (0.0113)
LPA Intensity	0.052** (0.0180)	0.028 (0.0187)	0.020 (0.0191)	0.040 (0.0246)	0.029 (0.0251)
Age		-0.005*** (0.0009)	-0.007 (0.0050)	-0.006*** (0.0012)	-0.013 (0.0069)
Age Squared			0.00001 (0.0001)		0.00006 (0.0001)
Employed		0.111** (0.0381)	0.073 (0.0402)	0.112* (0.0507)	0.088 (0.0555)
Wage*Employed		0.002 (0.0018)	0.002 (0.0016)	0.003 (0.0020)	0.003 (0.0016)
Education			0.044*** (0.0055)		0.050*** (0.0072)
Other Weekly Income			0.0002*** (0.00004)		0.0002** (0.0001)
Children			-0.025 (0.0154)		-0.038 (0.0199)
Married			0.012 (0.0330)		0.033 (0.0441)
Crime				0.004 (0.0132)	0.002 (0.0133)
Pedestrian Fatality				6.012 (5.9187)	5.589 (6.1189)
Sports Rental				-22.032 (15.9408)	-17.821 (16.2593)
Density				-0.001** (0.0004)	-0.001*** (0.0004)
Temperature				-0.003 (0.0095)	-0.007 (0.0098)
Temperature Sq				0.00004 (0.0001)	0.00008 (0.0001)
Precipitation				-0.004 (0.0146)	-0.004 (0.0154)
Part Time				-0.096 (0.0608)	-0.125* (0.0637)
Holiday				-0.384** (0.1240)	-0.326* (0.1485)
Weekday				0.042 (0.0365)	0.034 (0.0379)
Unemployment Rate				0.060 (0.0402)	0.043 (0.0410)
Observations	1,628	1,628	1,628	1,026	1,026
Pseudo R2	0.122	0.161	0.207	0.199	0.250

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 21  
 Probit models for the LPA intensity and duration effects on the health outcome conditional on the vigorous-intensity LPA

Variables	Probability of very good or excellent health				
Asian	-0.392** (0.1260)	-0.438*** (0.1161)	-0.507*** (0.1128)	-0.630*** (0.0941)	-0.727*** (0.0587)
Black	-0.322** (0.1130)	-0.314** (0.1198)	-0.208 (0.1307)	-0.146 (0.1725)	-0.038 (0.1701)
Hispanic	-0.407*** (0.0903)	-0.415*** (0.0942)	-0.269** (0.1005)	-0.513*** (0.1017)	-0.231 (0.1375)
Other Race	0.147 (0.1395)	0.129 (0.1363)	0.224*** (0.0666)	0.017 (0.2272)	0.191 (0.1122)
Male	-0.094 (0.0549)	-0.117* (0.0551)	-0.090 (0.0572)	-0.184* (0.0802)	-0.211** (0.0800)
LPA Duration	0.006 (0.0218)	0.008 (0.0232)	0.015 (0.0228)	0.028 (0.0283)	0.023 (0.0306)
LPA Intensity	-0.151*** (0.0454)	-0.135** (0.0452)	-0.148** (0.0463)	-0.236*** (0.0663)	-0.269*** (0.0705)
Age		-0.003 (0.0020)	0.010 (0.0109)	-0.003 (0.0030)	-0.010 (0.0169)
Age Squared			-0.0002 (0.0001)		0.00006 (0.0002)
Employed		0.086 (0.0757)	0.067 (0.0795)	0.041 (0.1041)	0.035 (0.1156)
Wage*Employed		0.010** (0.0037)	0.008 (0.0042)	0.013* (0.0056)	0.0003 (0.0063)
Education			0.047*** (0.0125)		0.084*** (0.0173)
Other Weekly Income			0.0003*** (0.0001)		0.0001 (0.0001)
Children			-0.056* (0.0283)		-0.099* (0.0395)
Married			0.119 (0.0715)		0.312*** (0.0931)
Crime				0.032 (0.0263)	0.003 (0.0273)
Pedestrian Fatality				-6.807 (16.5795)	16.678 (17.5566)
Sports Rental				-79.929 (54.2998)	1.183 (52.0723)
Density				-0.001 (0.0008)	0.0003 (0.0009)
Temperature				0.005 (0.0223)	0.014 (0.0221)
Temperature Sq				0.0002 (0.0002)	0.0002 (0.0002)
Precipitation				-0.060 (0.0329)	-0.082* (0.0338)
Part Time				-0.058 (0.1529)	-0.057 (0.1510)
Holiday				-0.242 (0.4378)	-0.643*** (0.1513)
Weekday				-0.041 (0.0839)	-0.104 (0.0829)
Unemployment Rate				-0.048 (0.1215)	0.042 (0.1229)
Observations	424	424	424	245	245
Pseudo R2	0.210	0.247	0.322	0.284	0.375

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 22

Probit models for the LPA intensity and duration effects on the health outcome conditional on blue-collar workers

Variables	Probability of very good or excellent health				
Asian	-0.182 (0.0952)	-0.161 (0.1000)	-0.189 (0.0983)	-0.238* (0.1175)	-0.253* (0.1145)
Black	-0.084 (0.0480)	-0.068 (0.0487)	-0.072 (0.0492)	-0.064 (0.0668)	-0.075 (0.0675)
Hispanic	-0.282*** (0.0394)	-0.267*** (0.0410)	-0.201*** (0.0444)	-0.379*** (0.0528)	-0.329*** (0.0575)
Other Race	-0.262** (0.0923)	-0.262** (0.0943)	-0.265** (0.0918)	-0.228 (0.1372)	-0.223 (0.1391)
Male	0.056 (0.0394)	0.028 (0.0410)	0.007 (0.0420)	-0.016 (0.0555)	-0.025 (0.0566)
LPA Duration	0.011 (0.0168)	0.008 (0.0168)	0.006 (0.0162)	-0.016 (0.0277)	-0.019 (0.0276)
LPA Intensity	0.022 (0.0120)	0.023 (0.0118)	0.023 (0.0119)	0.025 (0.0162)	0.024 (0.0161)
Age		-0.004** (0.0013)	-0.004 (0.0074)	-0.004* (0.0017)	-0.010 (0.0102)
Age Squared			0.000002 (0.0001)		0.00008 (0.0001)
Wage*Employed		0.011*** (0.0033)	0.008* (0.0033)	0.012* (0.0049)	0.010 (0.0051)
Education			0.035*** (0.0069)		0.026** (0.0091)
Other Weekly Income			0.00001 (0.0001)		0.00005 (0.0001)
Children			-0.011 (0.0157)		0.002 (0.0202)
Married			0.011 (0.0355)		-0.021 (0.0478)
Crime				0.019 (0.0132)	0.019 (0.0131)
Pedestrian Fatality				3.157 (5.4942)	4.291 (5.7225)
Sports Rental				7.539 (18.0096)	2.765 (18.0199)
Density				-0.001 (0.0006)	-0.001 (0.0006)
Temperature				0.012 (0.0108)	0.015 (0.0107)
Temperature Sq				-0.00003 (0.0001)	-0.00006 (0.0001)
Precipitation				0.005 (0.0204)	0.004 (0.0201)
Part Time				-0.085 (0.0737)	-0.099 (0.0765)
Holiday				-0.149 (0.1393)	-0.126 (0.1434)
Weekday				0.033 (0.0407)	0.030 (0.0410)
Unemployment Rate				0.019 (0.0473)	0.026 (0.0483)
Observations	1,371	1,371	1,371	852	852
Pseudo R2	0.117	0.127	0.142	0.179	0.188

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

Table 23

Probit models for the LPA intensity and duration effects on the health outcome conditional on white-collar workers

Variables	Probability of very good or excellent health				
Asian	-0.085** (0.0290)	-0.099*** (0.0295)	-0.132*** (0.0298)	-0.086* (0.0371)	-0.119** (0.0375)
Black	-0.133*** (0.0199)	-0.119*** (0.0202)	-0.094*** (0.0204)	-0.104*** (0.0252)	-0.074** (0.0254)
Hispanic	-0.195*** (0.0184)	-0.189*** (0.0191)	-0.126*** (0.0195)	-0.181*** (0.0235)	-0.111*** (0.0241)
Other Race	-0.120* (0.0472)	-0.123* (0.0478)	-0.102* (0.0490)	-0.123* (0.0606)	-0.117 (0.0608)
Male	0.003 (0.0118)	-0.014 (0.0121)	-0.017 (0.0123)	-0.004 (0.0154)	-0.008 (0.0158)
LPA Duration	0.006 (0.0087)	0.004 (0.0086)	0.002 (0.0085)	-0.002 (0.0105)	-0.003 (0.0104)
LPA Intensity	0.024*** (0.0040)	0.023*** (0.0040)	0.020*** (0.0040)	0.021*** (0.0050)	0.017*** (0.0050)
Age		-0.003*** (0.0005)	-0.005 (0.0030)	-0.004*** (0.0006)	-0.008* (0.0039)
Age Squared			0.00002 (0.00003)		0.00005 (0.00004)
Wage*Employed		0.006*** (0.0013)	0.003** (0.0011)	0.006*** (0.0015)	0.003* (0.0012)
Education			0.032*** (0.0027)		0.035*** (0.0034)
Other Weekly Income			0.00009*** (0.00002)		0.00007* (0.00003)
Children			-0.008 (0.0061)		-0.009 (0.0078)
Married			0.011 (0.0139)		0.021 (0.0177)
Crime				0.007 (0.0050)	0.007 (0.0050)
Pedestrian Fatality				-0.813 (1.9024)	-0.323 (1.8898)
Sports Rental				8.264 (6.5220)	8.702 (6.4670)
Density				-0.0002 (0.0002)	-0.0002 (0.0002)
Temperature				0.0004 (0.0037)	-0.001 (0.0037)
Temperature Sq				0.00001 (0.00004)	0.00002 (0.00004)
Precipitation				-0.001 (0.0069)	-0.0004 (0.0069)
Part Time				-0.046* (0.0201)	-0.032 (0.0214)
Holiday				-0.026 (0.0639)	-0.023 (0.0637)
Weekday				-0.021 (0.0146)	-0.018 (0.0148)
Unemployment Rate				-0.019 (0.0178)	-0.017 (0.0180)
Observations	7,452	7,452	7,452	4,844	4,844
Pseudo R2	0.065	0.075	0.093	0.084	0.105

Robust clustered standard errors adjusted for arbitrary correlation within county-year-month cells are reported in parentheses

\*\*\* p&lt;0.01, \*\* p&lt;0.05, \* p&lt;0.1

Notes: Each model specification includes month, year and county indicator. Dependent variable is dummy health that equals one with self-reported very good/excellent health status, otherwise zero. Marginal effects at means are reported in cells. The omitted group in the independent variables is White. Wage and other weekly income are in real values.

## REFERENCES

- Ainsworth, B.E. 2002. *The Compendium of Physical Activities Tracking Guide*. Prevention Research Center, Norman J. Arnold School of Public Health, University of South Carolina, [http://prevention.sph.sc.edu/tools/docs/documents\\_compendium.pdf](http://prevention.sph.sc.edu/tools/docs/documents_compendium.pdf).
- Colman, G., Dave, D. 2012. "Physical Activity and Health." *International Journal of Arts and Sciences* 5 (6): 29-45.
- Duncan, G. J., Homlund, B. 1983. "Was Adam Smith after all? Another Test of the Theory of Compensating Wage Differentials." *Journal of Labor Economics*, 1 (4), 366-379.
- Franco, O.H., de Laet, C., Peeters, A., Jonker, J., Mackenbach, J., Nusselder, W. 2005. "Effects of Physical Activity on Life Expectancy with Cardiovascular Disease." *Archives of Internal Medicine* 165 (20): 2355–2360.
- Gregory J. Colman, & Dave, D. 2011. "Exercise, Physical Activity, and Exertion over the Business Cycle." *NBER working paper 17406*.
- Grossman, M. 1972. "On the Concept of Health Capital and the Demand for Health." *Journal of Political Economy* 80 (2): 223-255.
- Grossman, M. 2006. "Education and Nonmarket Outcomes." In *Handbook of the Economics of Education*, Volume 1, edited by E. Hanushek and F. Welch, 577-633. Amsterdam: North-Holland, Elsevier Science.
- Heckman, J. J. 1979. "Sample Selection Bias as a Specification Error." *Econometrica*, 47, 153-161
- Lawlor, D A, Hopker, S W. 2001. "The effectiveness of exercise as an intervention in the management of depression: systematic review and meta-regression analysis of randomized controlled trials." *British Medical Journal* 322 (7289), 763-767.
- Lee, I. 1995. "Exercise Intensity and Longevity in Men." *JAMA: The Journal of the American Medical Association* 273 (15): 1179.
- Maruyama, S., Yin, Q. 2012. "The Opportunity Cost of Exercise: Do Higher-Earning Australians Exercise Longer, Harder, or Both?" *Health Policy* 106 (2):187-194.
- Meltzer, D., and Jena, A.B. 2010. "The Economics of Intense Exercise." *Journal of Health Economics* 29 (3):347-352.
- Saffer, H., Dave, D., Grossman, M., Leung, A.L. 2011. Race, Ethnic and Gender Differences in Physical Activity. *NBER working paper 17413*.