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Chapter Authors: Melayne M. McInnes, Judith A. Shinogle

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Physical Activity
Economic and Policy Factors

Melayne M. McInnes and Judith A. Shinogle

9.1 Introduction

While much research has focused on the costs of obesity and economic factors that drive obesity growth, little economic research has examined the factors that contribute to obesity—physical inactivity and poor nutrition. This chapter will examine correlates and predictors of physical activity over time with emphasis on economic factors. Using data for adults from the 2000 to 2005 Behavioral Risk Factor Surveillance System (BRFSS) survey, we examine the characteristics of individuals and their environments that determine their level of activity. Because BRFSS includes state and county codes for each individual, we are able to include additional information regarding economic variables such as price and supply variables.

9.2 Background

As more attention has been focused on the rising levels of obesity (defined as a Body Mass Index (BMI) of 30 or greater) in the United States, it is important to consider whether obesity trends are due to rising caloric intake, falling levels of activity, or both. Many studies have considered the economic factors that drive the obesity epidemic and caloric intake (Cutler et al. 2003; Anderson, Butcher, and Levine 2003; Rashad 2006; Smith, Bogin, and Bishai 2005; Bleich et al. 2007; Rashad and Markowitz 2007; Baum and

Melayne M. McInnes is associate professor of economics in the Moore School of Business at the University of South Carolina. Judith A. Shinogle is a senior economist at the Maryland Institute for Policy Analysis and Research.

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Ruhm 2007; Philipson 2001; Chou, Grossman, and Saffer 2004), but the physical activity side of the equation has received comparatively little attention. Even if changes in physical activity are not to blame for the dramatic changes in obesity, policies aimed at increasing physical activity may be a part of the solution. Understanding the determinants of physical activity is an important first step in determining whether policies aimed at increasing physical activity levels can be useful levers in reducing overall obesity levels.

9.3 Physical Activity and Health

Physical activity has unique health consequences. Murphy et al. (2007) find that activity as minimal as walking improves blood pressure control, lowers body fat percentages, and decreases BMI. Church et al. (2007) examines postmenopausal women with high blood pressure and finds that physical activity, even at low doses, improves cardiorespiratory fitness no matter the weight of the person. Other health research on the effects of obesity is starting to find that activity levels are important predictors of outcomes. Katzmarzyk, Church, and Blair (2004) find adding cardiorespiratory fitness to models comparing mortality (all cause and cardiovascular deaths) for men with metabolic syndrome to healthy men causes the association to be insignificant. They find that cardiorespiratory fitness provides a strong protective effect.

Besides examining health effects of physical activity, other researchers have estimated the impact of inactivity on medical expenditures. Keeler et al. (1989) find that those with sedentary lifestyles incur higher medical costs, but their life expectancy is less so they collect less public and private pensions. At a 5 percent rate of discount for future dollars, the lifetime subsidy from others to those with a sedentary lifestyle is estimated at $1,900. One more recent study examines the cost of inactivity to a health plan. Garret et al. (2004), utilizing a cost of illness methodology, finds that inactivity costs $86 million in one health plan. Another study utilizes the disease-by-disease epidemiological approach to examine the impact of inactivity in Canada. Katzmarzyk, Gledhil, and Shephard (2000) find that 2.5 percent of total direct health care costs in Canada in 1999 are attributable to physical inactivity. They further estimate that approximately 21,000 lives were lost prematurely in 1995 due to inactivity. Pratt, Macera, and Wang (2000) use the 1987 National Medical Expenditure Survey to perform a stratified analysis of medical expenditures and find that people who were physically active report an adjusted average annual medical expenditure of $1,019 compared to $1,349 for those who report being inactive. Shinogle (2008) uses linked National Health Interview Survey (NHIS) to Medical Expenditure Panel Survey (MEPS) to estimate the inactivity attributable fraction of medical expenditures range from 11 percent to 16 percent. In these models, inactivity

did not significantly increase the probability of a medical expenditure but did increase the level of expenditures. This result may reflect that physically active people have an unobserved taste for preventive health measures. This taste for prevention services is also indicated in the following analysis of the 2000 to 2005 National Health Interview Survey. Examining office-based visits by physically active people (as defined by the Centers for Disease Control and Prevention [CDC]) we find that active people are more likely to have one to two visits but less likely to have a higher number of office visits based on visits in the past twelve months (see table 9.1). On the other hand, examining emergency room visits and the number of overnight hospital days, we find the opposite association: physically active people have fewer of these more expensive medical uses.

9.4 Trends in Physical Activity

In light of the obesity epidemic, it is perhaps surprising that Americans are spending more of their time and income on leisure, and at least some of that is going to physical activity (Sturm 2004). Between 1965 and 2000, industries catering to leisure activity are generally growing more quickly than the overall economy, but a disproportionate share of this growth is in sedentary activities (such as cable tv viewing) rather than more active pursuits (sports clubs, dance studios). Nonetheless, time spent in physical activity is increasing. Sturm's analysis shows that between 1990 and 2000, the median increase in reported physical activity is twenty minutes per week. While most Americans still do not meet federal recommendations for physical activity, the CDC (2004) reports that between 1988 and 2002, there has been a 9 percentage point drop in the prevalence of no leisure time physical activity. Estimates of physical activity trends vary depending on the survey and questions used. As shown in table 9.2, the National Health Interview Survey (NHIS) finds around 30 percent of the adult population is inactive. This can be compared to estimates from the BRFSS showing that approximately 77 percent of the adult population participates in any leisure time physical activity in the past thirty days. While it is encouraging that the majority of Americans report getting some physical activity, a much lower percent report regularly engaging in moderate or vigorous exercise. The BRFSS estimates that approximately 25 percent of the population is involved in vigorous physical activity while 46 percent are involved in moderate or vigorous physical activity.

9.5 Physical Activity and Economics

Perhaps the most intriguing evidence of a link between physical fitness, health, and economic factors comes from Chris Ruhm's studies of age-adjusted mortality over the business cycle (2005, 2000). Ruhm finds that

Table 9.1 Health care utilization by activity status

Number of occurrences in past 12 months	Not regularly active (%)	Regularly active (%)
Office visits for regularly active compared to not regularly active		
0	20.1	17.8
1	15.5	18.7
2 to 3	23.5	28.0
4 to 5	13.8	13.8
6 to 7	7.1	6.6
8 to 9	4.0	3.2
10 to 12	6.5	5.0
13 to 15	2.6	1.9
16 or more	6.9	5.0
	$p < 0.001$	
Visits to ER for regularly active compared to not regularly active		
0	78.11	81.81
1	13.52	12.81
2 to 3	5.92	4.23
4 to 5	1.35	0.65
6 to 7	0.48	0.21
8 to 9	0.17	0.09
10 to 12	0.22	0.10
13 to 15	0.06	0.03
16 or more	0.15	0.06
	$p < 0.001$	
Times in hospital overnight for regularly active compared to not regularly active		
0	88.4	92.8
1	8.4	5.9
2	1.9	0.9
3	0.7	0.2
>3	0.6	0.2
	$p < 0.001$	

Source: Shinogle (2008).

Table 9.2 Estimates of physical activity (PA) from two surveys 2001–2005

	Percent of adult population				
	2001	2002	2003	2004	2005
NHIS: "inactive"	29.9	30.1	29.5	30.4	29.3
BRFSS: "any exercise"	75.9	76.9	77.2	77.3	77.6
BRFSS: "vigorous PA"			25.0		24.5
BRFSS: "moderate or vigorous PA"			45.6		45.7

Source: Authors' tabulations from NHIS and BRFSS.

declines in mortality during temporary economic downturns are accompanied by increases in leisure time physical activity, declines in BMI, and smoking. These changes disproportionately occur among the least active, most severely obese, and heaviest smokers, respectively. Ruhm's findings point to the important role that economic levers can have in shaping physical activity levels and the need to better understand the relationships between lifestyle behaviors such as physical activity and smoking. If there are economies of scope in reducing unhealthy behaviors, then policymakers may be able to exploit this when designing a policy that ostensibly targets only one of these behaviors.

More recently, using the BRFSS 1996 to 2000, Rashad (2006) develops a model of cycling propensity and the health gains that result. Cycling rates are lower for those who are working, those with higher incomes, and females. She also finds that cycling rates respond negatively to urban sprawl and real gas prices, and that increased cycling is associated with significant health gains.

Another important aspect in the economics of physical activity is the time constraint. Mullahy and Rober (2008) examine the 2005 and 2006 American Time Use Study to explore factors associated with time spent in physical activity (PA). They find differences not only by gender but also by when the time is spent—during the week or on weekends. Education is associated with increased physical activity on weekends/holidays for both men and women. Males show a decline in physical activity as they age, and males with spouses have lower physical activity than those without. For females, physical activity is reduced on weekends and holidays. Further research is warranted on how shocks in time use (such as children, marriage, job change) affect physical activity.

9.6 Physical Activity and Policy

Policies directly aimed at promoting greater physical activity have almost exclusively focused on physical education in schools (Yancey et al. 2007). Increased physical education requirements generally do translate into more minutes of PE, but do not appear to alter obesity levels and do not clearly increase physical activity (Cawley, Meyerhoefer, and Newhouse 2005). Policy targeting the built environment may also promote physical activity, given studies that find the proximity and attractiveness of recreational facilities does appear to promote physical activity (Yancey et al. 2007). State and local spending on parks and recreation increases the likelihood and amount of participation in outdoor sports (Humphreys and Ruseki 2007). Outdoor sports, however, are a small component of physical activity (only 5 percent of BRFSS participants report participation in outdoor recreation such as backpacking, fishing, hiking, or waterskiing), and other more common forms of exercise, such as walking, were not affected by state spending levels.

The built environment is a key issue for policy aimed at increasing physical activity. Brownson, Boehmer, and Luke (2005) examine trends in activity for leisure, work, travel, and related behaviors and find that a combination of changes in the built environment and an increase in proportion of the population engaging in sedentary behaviors (such as television viewing) puts a significant part of the population at risk for physical inactivity. Another recent study finds that counties with a Walmart® are associated with lower physical activity, but the BMI in these counties is actually lower than those without a Walmart®. Adults in counties with Walmarts® have higher fruit and vegetable consumption and lower fat consumption than counties without a Walmart®. Having lower priced commodities close by increases the purchasing power of consumers, allowing for the purchase of higher cost, healthier foods (Courtemanche and Carden 2008).

Other government policies may have unintended spillover effects that indirectly promote or discourage physical activity levels. Rashad's study of cycling suggests that gas taxes may have an unintended benefit in terms of promoting physical activity. Other policies, such as those aimed at reducing smoking, may also have unintended consequences for physical activity. Clean indoor air policies and cigarette prices are both weakly associated with increased BMI (Chou, Grossman, and Saffer 2004, 2006). Given possible interactions between lifestyle behaviors, the spillover effects from policies aimed at reducing smoking are difficult to predict. Former smokers and less intense smokers may find leisure physical activity more enjoyable and more necessary to compensate for weight gain. On the other hand, when mandated to reduce risk along one margin, individuals may choose to offset this by increasing risk along another margin (Pelzman 1975). We discuss these effects in more detail later.

9.7 Basic Model of Economic Determinants of Physical Activity

In a model of household production, the price of physical activity includes the opportunity cost of time and the cost of inputs to physical activity. Thus, we consider later on factors that affect the individual's opportunity cost of time (such as education and income) as well as some input prices. We also consider whether environmental variables, such as availability of parks and crime rates, have an effect on physical activity levels. We also consider whether transportation costs and availability affect physical activity. An important question is whether other health behaviors are substitutes or complements with physical activity. For example, if one thinks of smoking as a weight reduction device, would the decrease in smoking cause individuals to find other weight reduction behavior such as physical activity? On the other hand, if smoking is an indicator for overall risky health behavior, a change in smoking would not affect physical activity. We make similar arguments for drinking.

Suppose that the individual receives utility from health H, physical activity A, and other goods Z as measured by the utility function $U(H, A, Z)$. Health depends on physical activity A and consumption of goods Z: $H(A, Z)$. Individuals produce physical activity by combining time and other exercise inputs (gym services, exercise equipment, natural amenities, physical trainer services, etc.): $A = A(x_A, t_A)$. Time inputs include the time spent in the activity as well as any travel time incurred to get to the bike path, gym, safe neighborhood for walking, or other exercise venue.

The vector Z includes goods that may be complements or substitutes for physical activity in two different pathways: (a) consumption, and (b) production of health. For a consumption example, a person might substitute an hour of drinking in a pub with friends for an hour of sailing, depending on which is cheaper. On the production side, a person who does not value exercise for it's own sake might increase activity levels if this were to enhance the productivity of other inputs to the health production. For example, reduced smoking may increase the productivity of exercise making the two complements in production. The consumer is assumed to maximize utility $U(H, A, Z)$ subject to the time constraint and income constraints yielding the Langrangian:

$$L = U(H(A, Z), A, Z) - \lambda_m[\text{Income} = p_A X_A + p_Z X_Z + wX_A + wX_Z] - \lambda_t[24 = t_A + t_w + t_z].$$

Assuming that both constraints are binding, and treating A as the choice variable, we can write the Lagrangian in terms of the full income constraint as:

$$L = U(H(A, Z), A, Z) - \lambda[w24 = p_A X_A + p_Z X_Z + wt_A + wt_Z].$$

The first order condition for the level of physical activity is then:

$$U_H H_A + U_A = \lambda[p_A \partial X_A/\partial A + p_A \partial t_A/\partial A].$$

The left-hand side shows that the marginal benefit of physical activity includes the indirect effect through the health production as well as from the direct effect from enjoyment of the activity (or disutility, as individual tastes dictate.) The right-hand side measures the full price of physical activity and includes the opportunity cost of time, as well as the price of physical activity inputs. This first order condition applies to individuals who engage in some physical activity, but a substantial fraction of the population will be at a corner solution with:

$$U_H H_A + U_A - \lambda[p_A \partial X_A/\partial A + p_A \partial t_A/\partial A] < 0.$$

The first-order condition from this simple static model suggests several ways in which policy and price changes affect an individual's level of physical activity.

Own price. Policies that affect the full price of exercise include anything that reduces the cost of inputs to physical activity or the time cost of engaging in exercise. For example, the construction of new parks will reduce the travel time of individuals who live near the park. The built environment, which may affect the cost of exercise as well as the enjoyment of exercise, has been the subject of much study and the results are mixed. For example, Forsyth et al. (2007) find no relationship between residential density and overall physical activity. Decreases in physical activity on the job in combination with rising wages may both increase the opportunity cost of exercise (Philipson 2001). Our model includes measures of education, income, and employment status as factors that affect the opportunity cost of time. Because factors may also affect the cost of missed work due to poor health and the efficiency of health production, we do not have an unambiguous prediction of sign.

Prices of related goods. In looking at the effects of alcohol and tobacco prices on BMI and obesity, Cho, Grossman, and Saffer (2004, 2006) find that both weight measures increase with cigarette prices but decrease with alcohol prices. Thus, they suggest that calories and cigarettes are substitutes, while calories and alcohol are complements. The weight changes found by Cho, Grossman, and Saffer may also reflect changes in activity levels in addition to changes in caloric intake. For example, since the health benefits from exercise may ameliorate the damages from smoking and drinking, exercise may be a complement in the production of health to smoking or drinking. If that is the case, then policies that decrease smoking and drinking may decrease exercise as they no longer see the need for this offsetting health behavior. Alternatively, there may be complementarity in consumption. This may occur as one gets a pleasurable feeling from all three activities; thus, as the price increases for smoking, one may substitute with physical activity. Complementarities may also occur when individuals are trying to make behavioral changes. Changes in one health behavior may serve as a "gateway" for changes in other health behaviors (see Dutton et al. 2008, for an example). One may also have the "New Year's resolution effect" in that a person finds it easier to change a group of behaviors together, and thus simultaneously decreasing smoking and drinking while increasing physical activity.

The previous model is static and does not address the fact that some of the benefits and costs of physical activity are not immediately felt. The expression "no pain, no gain" illustrates the intertemporal tradeoffs that some people perceive in exercise. Other activities such as exercising, refraining from smoking, and controlling weight may share the characteristic of increasing short-term disutility and long health. Hence, we might find a high degree of correlation among health behaviors due to the unobserved taste parameter of time preference in a cross-sectional analysis.

9.7.1 Data and Methods

Data are from the Behavioral Risk Factor Surveillance System, a large nationally representative telephone survey of the noninstitutionalized adult population administered by the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention 2004). All states participated between 2000 and 2005. We drop any pregnant women from the analysis, as physical activity recommendations are dependent on prior physical fitness. Annual sample sizes range from approximately 112,000 to over 258,000 leading to a combined sample size of over 1 million observations when all six years are used.

We utilize three different measures of physical activity as BRFSS obtains different information each year. Annually, BRFSS asks if the person participated in ANY leisure time physical activity in the past thirty days. This is a weak measure as it could be as simple as walking once in the past thirty days. The advantage of using this measure is that the question is asked every year and can be used to measure changes over time. The second and third measures follow the definitions created by the CDC. The first measure—physical activity that is vigorous or moderate—is defined as engaging in light to moderate leisure time physical activity for greater than or equal to thirty minutes at a frequency of greater than or equal to five times per week, or engaging in vigorous leisure time physical activity for greater than or equal to twenty minutes at a frequency greater than or equal to three times a week. Our last measure examines those that only have vigorous physical activity. These last two measures of physical activity are only asked on odd years and thus reduce our analysis to years 2001, 2003, and 2005.

Basic demographic data include age, age squared, race (black, white, Asian, with other race as the omitted category), Hispanic ethnicity, education (high school graduate, some college, college plus, with the omitted category less than high school graduate), eight household income categories (over $75,000 as omitted), married, and employment (unemployed, retired, student or homemaker with employed as omitted category). We test the effects of adding weight status that may be correlated with unobservables such as taste for health prevention or discount rates. We also add whether the individual got a flu shot. We include the flu shot as a measure of the person's tendency toward preventive care.

Data on area characteristics was obtained from a number of sources. Data on the number of establishments and employment in recreational industries and parks are obtained from the County Business Patterns Data Set from the Census. We created three measures: the number of fitness and recreation centers per 1,000 individuals in a county ("gyms per capita"; North American Industry Classification System [NAICS] code 713940), parks per 1,000 individuals in a county (NAICS code 712190), and the number of other

recreation areas per 1,000 in a county (NAICS code for golf and country clubs 713190, ski venues 713920, marinas 713930, bowling facilities 713950, and all other 713990). Data on state tax policy for alcohol and tobacco are obtained from the Federation of Tax Administrators. We also added the American Chamber of Commerce Researchers' Association (ACCRA) data on pre-tax retail prices for tennis balls, bowling, bus fare, and gas. County level crime statistics for violent crime rate (murder, forcible rape, robbery, aggravated assault) and property crime rate (burglary, larceny-theft, motor vehicle theft, arson) from the FBI Uniform Crime Report System were added (U.S. Department of Justice, Federal Bureau of Investigation 2006).

We begin our analysis of the data by building a baseline model of participation in any leisure time physical activity in the past thirty days. Our strategy is to begin with a small set of demographic and socioeconomic variables and then proceed by adding additional variables in groups to examine the effects of the additional variables on existing variables' stability. The second group of variables includes area characteristics. Next, we add weight status (overweight and obese) to see whether the estimated effects of area characteristics are sensitive to the inclusion of a health status measure. Because weight measures are likely endogenous, we exclude them in the remaining specifications and consider instead a measure of risk attitude for health—did the person have a flu shot in the last twelve months? Finally, because exercise is measured for past thirty days and weather or climate for the time of year may affect the likelihood of exercise, we add month of interview fixed effects.

Because previous studies have found differences in women and men in their physical activity participation, we reanalyzed all models stratifying by gender. In addition, as access to amenities may vary by income, we again examined our results stratifying by income. All models include year, month, and state fixed effects and are run as simple linear probability models with robust standard errors. Therefore, we can interpret the estimates for state-level variables as measuring how physical activity changes due to changes in these independent variables.

Because more rigorous exercise habits are recommended in the health literature, we also consider two alternative measures of exercise: participation in vigorous exercise or participation in moderate or vigorous activity.

9.7.2 Results

Table 9.3 presents the means and standard deviations for our data set. These are means averaged over the six years of the data, and as such, the physical activity measure differs from those presented on an annual basis in the tables presented earlier. Over these six years, approximately 70 percent of our sample had any exercise. Yet, few met the CDC's definition of active with only 12 percent reporting moderate or vigorous activity, and only 7 percent reporting vigorous activity. Our sample is of adults, and the average age is

Table 9.3 Descriptive statistics

Variable	Mean	Std. dev.	Min.	Max.
Any leisure time activity in past 30 days	0.696	0.460	0	1
Moderate or vigorous PA	0.124	0.330	0	1
Vigorous PA	0.068	0.252	0	1
Age	47.874	16.594	18	99
Age squared	2567.315	1710.999	324	9,801
Male	0.420	0.494	0	1
Hispanic	0.068	0.252	0	1
White	0.833	0.373	0	1
Black	0.070	0.255	0	1
Asian	0.023	0.149	0	1
Married	0.574	0.494	0	1
High school diploma	0.284	0.451	0	1
Some college	0.285	0.451	0	1
College degree or more	0.351	0.477	0	1
Income < $10K	0.048	0.214	0	1
Income $15k < $20k	0.053	0.224	0	1
Income $20k < $25k	0.074	0.261	0	1
Income $25k < $30k	0.097	0.297	0	1
Income $30k < $35k	0.144	0.351	0	1
Income $35k < $50k	0.182	0.386	0	1
Income $50k < $75k	0.180	0.384	0	1
Income > $75k	0.221	0.415	0	1
Unemployed	0.043	0.203	0	1
Student or homemaker	0.097	0.295	0	1
Retired	0.175	0.380	0	1
Insured	0.882	0.323	0	1
Price of bowling	3.014	0.680	1	8.34
Price of tennis balls	2.427	0.387	1.51	4.99
Price of gas	1.553	0.258	0.98	2.54
Bus fare	1.125	0.498	0.25	3.35
Unemployment rate	5.233	1.597	1.6	15.9
Violent crime rate	4.473	3.329	0	48.31
Property crime rate	38.248	16.113	0	217.37
Number of gyms per capita	0.103	0.047	0	0.48
Number of parks per capita	0.002	0.007	0	0.14
Number of other rec areas per capita	0.141	0.114	0	2.72
Cigarette tax	0.690	0.474	0.025	2.05
Beer tax	0.214	0.154	0.02	0.92
Overweight	0.350	0.477	0	1
Obese	0.223	0.416	0	1
Flu shot	0.327	0.469	0	1
Number of observations = 383,950				

close to forty-eight years old with the sample being predominantly white (83 percent) and female (58 percent).

After briefly reviewing the results of all models, we discuss in more detail the overall findings for key variables of interest across different specifications.

Baseline Model: Participation in Any Leisure Time Exercise

Results for models of participation in any leisure time physical activity in the past thirty days are presented in table 9.4. Model 1 in table 9.4 includes only demographic variables and shows that the likelihood of reporting participation in any leisure physical activity decreases for those who are older, female, married, and uninsured. Those who are employed are less likely to exercise during leisure time than students and homemakers, retirees, or unemployed individuals. Greater education and income are associated with an increase in the probability of engaging in some exercise. Comparing coefficient estimates for the demographic variables across the columns in table 9.4 shows that the estimated effects are robust to the inclusion of additional variables.

In model 2 of table 9.4, we include area variables to capture variation in local availability of exercise venues, economic conditions, and crime. While we would like to measure the causal impacts of changes in these area variables on physical activity, we interpret our coefficient estimates as correlation measures due to concerns over reverse causality. Healthy, active individuals may self-select areas with particular characteristics. While our analysis can exploit intertemporal variation in these measures, and we include state and year fixed effects in all models, our concern remains that there are unobservable factors correlated with both area characteristics and the decision to engage in exercise.

The number of gyms per capita, parks per capita, and other exercise venues per capita are all positively associated with increased exercise participation. We find no relationship between participation in any exercise and the property crime rate or violent crime rate for an individual's county. Given the findings that obesity is related to cigarette prices and tax rates (Chou, Grossman, and Saffer 2004, 2006; Gruber and Frakes 2006) we might expect to find a relationship between sin taxes (cigarette and beer taxes) and physical activity. In particular, the puzzling finding of Gruber and Frakes (2006) that obesity *declines* when cigarette taxes increase might make more sense if we found higher taxes were associated with increased exercise. As individuals smoke less, they may decide to make overall health changes and exercise more. Our results in table 9.4 do not support this conjecture. We find no association between beer or cigarette taxes and participation in any leisure time exercise.

We do, however, find a link between transportation costs and exercise. Bus fare is positive and significant in all specifications while gas prices are

Table 9.4 **Participation in any exercise**

	Model 1: Basic demographics	Model 2: Add area variables to model 1	Model 3: Add weight to model 2	Model 4: Add flu shots to model 2	Model 5: Add months to model 4
Age	–0.0027*	–0.0025*	–0.0012*	–0.0024*	–0.0024*
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
Age squared	–3.03E-06*	–5.42E-06	–1.79E-05	–7.02E-06	–7.16E-06*
	(1.4E-06)	(2.3E-06)	(2.3E-06)	(2.3E-06)	(2.3E-06)
Male	0.0219*	0.0228*	0.0249*	0.0230*	0.0236*
	(0.0008)	(0.0013)	(0.0013)	(0.0013)	(0.0013)
Hispanic	–0.0389*	–0.0402*	–0.0407*	–0.0404*	–0.0405*
	(0.0018)	(0.0028)	(0.0028)	(0.0028)	(0.0028)
White	0.0188*	0.0141*	0.0115*	0.0141*	0.0146*
	(0.0016)	(0.0026)	(0.0025)	(0.0026)	(0.0025)
Black	–0.0289*	–0.0346*	–0.0294*	–0.0342*	–0.0341*
	(0.0021)	(0.0035)	(0.0034)	(0.0035)	(0.0034)
Asian	–0.0540*	–0.0702*	–0.0809*	–0.0704*	–0.0695*
	(0.0032)	(0.0049)	(0.0048)	(0.0048)	(0.0048)
Married	–0.0129*	–0.0148*	–0.0139*	–0.0149*	–0.0149*
	(0.0009)	(0.0014)	(0.0014)	(0.0014)	(0.0014)
High school diploma	0.0735*	0.0786*	0.0772*	0.0785*	0.0783*
	(0.0015)	(0.0025)	(0.0025)	(0.0025)	(0.0025)
Some college	0.1340*	0.1370*	0.1350*	0.1370*	0.1360*
	(0.0015)	(0.0026)	(0.0026)	(0.0026)	(0.0026)
College degree or more	0.1800*	0.1820*	0.1770*	0.1820*	0.1810*
	(0.0016)	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Income < $10k	–0.1980*	–0.1920*	–0.1840*	–0.1920*	–0.1910*
	(0.0021)	(0.0034)	(0.0034)	(0.0034)	(0.0034)
Income $15k < $20k	–0.1780*	–0.1730*	–0.1660*	–0.1730*	–0.1730*
	(0.0020)	(0.0033)	(0.0033)	(0.0033)	(0.0033)
Income $20k < $25k	–0.1510*	–0.1480*	–0.1420*	–0.1480*	–0.1470*
	(0.0018)	(0.0029)	(0.0029)	(0.0029)	(0.0029)

(*continued*)

Table 9.4 (continued)

	Model 1: Basic demographics	Model 2: Add area variables to model 1	Model 3: Add weight to model 2	Model 4: Add flu shots to model 2	Model 5: Add months to model 4
Income \$25k < \$30k	–0.1240*	–0.1230*	–0.1170*	–0.1220*	–0.1220*
	(0.0016)	(0.0026)	(0.0026)	(0.0026)	(0.0026)
Income \$30k < \$35k	–0.0919*	–0.0896*	–0.0855*	–0.0894*	–0.0893*
	(0.0014)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
Income \$35k < \$50k	–0.0623*	–0.0599*	–0.0563*	–0.0598*	–0.0597*
	(0.0013)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Income \$50k < \$75k	–0.0349*	–0.0348*	–0.0322*	–0.0347*	–0.0346*
	(0.0012)	(0.0020)	(0.0020)	(0.0020)	(0.0020)
Unemployed	0.0089*	0.0140*	0.0147*	0.0142*	0.0143*
	(0.0020)	(0.0031)	(0.0031)	(0.0031)	(0.0031)
Student or homemaker	0.0451*	0.0393*	0.0369*	0.0396*	0.0398*
	(0.0014)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
Retired	0.0731*	0.0675*	0.0672*	0.0666*	0.0664*
	(0.0014)	(0.0023)	(0.0023)	(0.0023)	(0.0023)
Insured	0.0131*	0.0121*	0.0141*	0.0109*	0.0112*
	(0.0012)	(0.0020)	(0.0020)	(0.0021)	(0.0020)
Price of bowling		–0.0044	–0.0046	–0.0042	–0.0027
		(0.0028)	(0.0028)	(0.0028)	(0.0028)
Price of tennis balls		–0.0012	–0.0017	–0.0011	0.0001
		(0.0024)	(0.0024)	(0.0024)	(0.0024)
Price of gas		–0.0108*	–0.0103	–0.0104	–0.0102
		(0.0053)	(0.0053)	(0.0053)	(0.0053)
Bus fare		0.0118*	0.0123*	0.0113*	0.0073*
		(0.0035)	(0.0035)	(0.0035)	(0.0035)
Violent crime rate		–0.0008	–0.0009	–0.0008	–0.0008*
		(0.0003)	(0.0003)	(0.0003)	(0.0003)

Property crime rate		–2.54E-05	–2.20E-05	–2.86E-05	–3.73E-05
		(6.6E-06)	(6.6E-06)	(6.6E-06)	(6.6E-06)
Number of gyms per capita		0.1100*	0.0959*	0.1100*	0.1080*
		(0.0149)	(0.0149)	(0.0149)	(0.0149)
Number of parks per capita		0.2570*	0.2340*	0.2590*	0.2510*
		(0.0900)	(0.0897)	(0.0900)	(0.0898)
Number of other rec areas per capita		0.0239*	0.0217*	0.0244*	0.0250*
		(0.0065)	(0.0065)	(0.0065)	(0.0065)
Cigarette tax		0.0009	0.0008	0.0014	–0.0025
		(0.0042)	(0.0042)	(0.0042)	(0.0042)
Beer tax		0.0274	0.0257	0.0277	0.0175
		(0.0607)	(0.0605)	(0.0607)	(0.0606)
Overweight			–0.0065*		
			(0.0014)		
Obese			–0.0733*		
			(0.0016)		
Flu shot				0.0122*	0.0119*
				(0.0014)	(0.0014)
Observations	1,057,541	383,950	383,950	383,950	383,950
R^2	0.323	0.339	0.342	0.339	0.341

Notes: Standard errors in parentheses.
*Significant at the 10 percent level.

negative but generally insignificant. One interpretation of these results is that driving one's self is a complement to leisure time physical activity while activities available to bus riders are substitutes for leisure time exercise. As an example, high gas prices may decrease car trips to the gym while increased bus fares make playing basketball at a neighborhood park cheaper relative to taking the bus to see a movie. This explanation suggests we will see a stronger effect of bus fare at the low end of the income scale. Our stratifications by income, reported later, allow us to examine this conjecture more closely. The two exercise "prices" we include are probably poor proxies for an index of leisure time physical activity prices, and we find no significant effects for these variables in any model in table 9.4.

In the third and fourth columns of table 9.4, we find that the two measures of health status, maintaining a healthy weight and getting a flu shot, are both positively associated with leisure time physical activity. The estimated associations between availability of exercise amenities and the likelihood of engaging in exercise do not appear to be sensitive to inclusion of health status measures. In the final column, we show that adding fixed effects for month of interview reduces slightly the estimated association between most area variable and physical activity, but the significance is not changed.

Any Exercise: Stratified by Gender

Stratifying by gender reveals some interesting differences between the factors that affect men's and women's participation in any leisure time physical activity. We report these results for our preferred specification in table 9.5. The relationship between increasing income and the likelihood of exercise found in the pooled sample holds for both women and men. Similarly, the effects of employment (relative to unemployment or being out of the labor force) and marriage continue to hold in the stratified samples. The positive association between health insurance and exercise, however, holds only for men. The number of gyms per capita is significant for both men and women, but parks per capita and other exercise venues (e.g., ski areas and marinas) are positive and significant only for women. Because women's propensity to engage in exercise varies with the availability of outdoor exercise venues, we might expect greater sensitivity to crime rates. However, we do not find a significant association between exercise and crime rate in either stratified regression. Nor do we find any relationship between sin taxes and exercise. In examining price factors, we find that the positive association between bus fare and exercise participation found in the pooled regression holds only for women.

These results show that for both men and women, the greater the opportunity cost of physical activity because of work and higher earnings or because of reduced availability of exercise amenities, the lower the participation in physical activity. Nonpecuniary factors such as crime rates appear to have little effect. Perhaps the most interesting difference is the effect of overweight

Table 9.5 **Participation in any exercise, stratified by gender**

	Female	Male
Age	–0.0004	–0.0052*
	(0.0003)	(0.0003)
Age squared	–2.62E-05*	2.04E-05*
	(–3.02E-06)	(–3.51E-06)
Hispanic	–0.0464*	–0.0319*
	(0.0037)	(0.0040)
White	0.0192*	0.0097*
	(0.0035)	(0.0037)
Black	–0.0453*	–0.0104*
	(0.0046)	(0.0052)
Asian	–0.0778*	–0.0604*
	(0.0068)	(0.0068)
Married	–0.0204*	–0.0080*
	(0.0019)	(0.0020)
High school diploma	0.0805*	0.0756*
	(0.0034)	(0.0037)
Some college	0.1400*	0.1320*
	(0.0035)	(0.0038)
College degree or more	0.1880*	0.1730*
	(0.0036)	(0.0038)
Income < $10k	–0.1920*	–0.1860*
	(0.0045)	(0.0056)
Income $15k < $20k	–0.1720*	–0.1730*
	(0.0043)	(0.0053)
Income $20k < $25k	–0.1480*	–0.1470*
	(0.0039)	(0.0045)
Income $25k < $30k	–0.1210*	–0.1270*
	(0.0036)	(0.0039)
Income $30k < $35k	–0.0852*	–0.0968*
	(0.0031)	(0.0033)
Income $35k < $50k	–0.0572*	–0.0643*
	(0.0028)	(0.0029)
Income $50k < $75k	–0.0345*	–0.0353*
	(0.0028)	(0.0027)
Unemployed	0.0120*	0.0181*
	(0.0041)	(0.0046)
Student or homemaker	0.0398*	0.0526*
	(0.0025)	(0.0058)
Retired	0.0689*	0.0610*
	(0.0031)	(0.0035)
Insured	0.0053	0.0197*
	(0.0028)	(0.0030)
Price of bowling	–0.0055	0.0012
	(0.0037)	(0.0041)
Price of tennis balls	–0.0008	0.0015
	(0.0033)	(0.0036)
Price of gas	–0.0081	–0.0130
	(0.0072)	(0.0079)

(*continued*)

Table 9.5 (continued)

	Female	Male
Bus fare	0.0096*	0.0042
	(0.0047)	(0.0051)
Violent crime rate	–0.0006	–0.0010
	(0.0005)	(0.0005)
Property crime rate	–0.0001	6.02E-05
	(0.0001)	(0.0001)
Number of gyms per capita	0.0805*	0.142*
	(0.0202)	(0.0219)
Number of parks per capita	0.2660*	0.225
	(0.1220)	(0.1320)
Number of other rec areas per capita	0.0315*	0.0182
	(0.0089)	(0.0095)
Cigarette tax	–0.0023	–0.00253
	(0.0057)	(0.0062)
Beer tax	0.1110	–0.109
	(0.0828)	(0.0882)
Flu shot	0.0077*	0.0159*
	(0.0019)	(0.0021)
Observations	222,823	161,127
R^2	0.323	0.369

Notes: Standard errors in parentheses.
*Significant at the 10 percent level.

status. In the pooled regression, we found overweight to be negative and significant but it becomes positive and significant when we look at only men. Concern exists regarding the accuracy of BMI in diagnosing obesity. A study found that BMI had a better correlation with lean mass than body fat percentages (Romero-Corral et al. 2008); hence, active men with high muscle mass may be misclassified as overweight.

Results for Models of Vigorous Exercise

In the first column of table 9.6 we report the results for our preferred model for the pooled sample using participation in vigorous exercise as the dependent variable. The second two columns show the estimates for the models stratified by gender. The effects of age, gender, income, employment, and marital status are qualitatively similar to the findings for any exercise, but we find some changes in the estimated effects of race and insurance status. In comparing the correlations between area variables and physical activity, we find that none of the measures is significant for males, but gyms and other amenities are positive and significant for the pooled sample and for women. Sin taxes now have a negative and significant association with vigorous exercise (with the exception of cigarette taxes for women), indicating that higher taxes are associated with decreases in vigorous activity. We

Table 9.6 Participation in vigorous exercise

	Model 1: Females and males	Model 2: Female	Model 3: Male
Age	–0.0027*	–0.0022*	–0.0031*
	(0.0001)	(0.0002)	(0.0002)
Age squared	1.20E-05*	8.56E-06*	1.46E-05*
	(1.4e-06)	(1.7e-06)	(2.3e-06)
Male	0.0167*		
	(0.0008)		
Hispanic	–0.0067*	–0.0077*	–0.0045*
	(0.0016)	(0.0021)	(0.0026)
White	–0.0010	0.0003	–0.0032
	(0.0015)	(0.0020)	(0.0024)
Black	–0.0057*	–0.0096*	0.0020*
	(0.0021)	(0.0026)	(0.0034)
Asian	–0.0366*	–0.0351*	–0.0386*
	(0.0029)	(0.0038)	(0.0045)
Married	–0.0084*	–0.0075*	–0.0085*
	(0.0008)	(0.0011)	(0.0013)
High school diploma	0.0064*	0.0037*	0.0093*
	(0.0015)	(0.0019)	(0.0024)
Some college	0.0139*	0.0125*	0.0153*
	(0.0015)	(0.0019)	(0.0025)
College degree or more	0.0264*	0.0242*	0.0298*
	(0.0016)	(0.0020)	(0.0025)
Income < $10k	–0.0485*	–0.0469*	–0.0545*
	(0.0021)	(0.0025)	(0.0037)
Income $15k < $20k	–0.0419*	–0.0431*	–0.0410*
	(0.0020)	(0.0024)	(0.0035)
Income $20k < $25k	–0.0385*	–0.0398*	–0.0374*
	(0.0018)	(0.0022)	(0.0029)
Income $25k < $30k	–0.0346*	–0.0361*	–0.0326*
	(0.0016)	(0.0020)	(0.0026)
Income $30k < $35k	–0.0284*	–0.0312*	–0.0247*
	(0.0014)	(0.0017)	(0.0022)
Income $35k < $50k	–0.0234*	–0.0241*	–0.0222*
	(0.0012)	(0.0016)	(0.0019)
Income $50k < $75k	–0.0155*	–0.0169*	–0.0137*
	(0.0012)	(0.0015)	(0.0018)
Unemployed	0.0044*	–0.0029	0.0143*
	(0.0018)	(0.0023)	(0.0030)
Student or homemaker	0.0126*	0.0107*	0.0275*
	(0.0013)	(0.0014)	(0.0038)
Retired	0.0103*	0.0128*	0.0067*
	(0.0014)	(0.0018)	(0.0023)
Insured	–0.0007	–0.0013	0.0007
	(0.0012)	(0.0016)	(0.0019)
Price of bowling	–0.0011	0.0009	–0.0036
	(0.0016)	(0.0021)	(0.0027)

(*continued*)

Table 9.6 (continued)

	Model 1: Females and males	Model 2: Female	Model 3: Male
Price of tennis balls	0.0061*	0.0074*	0.0050*
	(0.0015)	(0.0018)	(0.0024)
Price of gas	–0.0203*	–0.0239*	–0.0160*
	(0.0032)	(0.0040)	(0.0052)
Bus fare	0.0108*	0.0066*	0.0155*
	(0.0021)	(0.0026)	(0.0034)
Violent crime rate	8.30E-05	0.0001	5.33E-05
	(0.0002)	(0.0003)	(0.0003)
Property crime rate	–2.93E-05	–1.46E-05	–4.40E-05
	(3.9E-05)	(4.9E-05)	(0.0001)
Number of gyms per capita	0.0308*	0.0520*	0.0001
	(0.0089)	(0.0113)	(0.0143)
Number of parks per capita	0.0235	0.0009	0.0629
	(0.0536)	(0.0677)	(0.0864)
Number of other rec areas per capita	0.0124*	0.0136*	0.0109
	(0.0039)	(0.0049)	(0.0062)
Cigarette tax	–0.0094*	–0.0041	–0.0149*
	(0.0025)	(0.0032)	(0.0041)
Beer tax	–0.1410*	–0.0957*	–0.1570*
	(0.0362)	(0.0461)	(0.0576)
Flu shot	0.0018*	–0.0016*	0.0062*
	(0.0008)	(0.0011)	(0.0014)
Observations	383,950	222,823	161,127
R^2	0.22	0.193	0.256

Note: Standard errors in parentheses.
*Significant at the 10 percent level.

expect higher sin taxes will lead to reductions in smoking and drinking, but the resulting health gains may be offset by the concomitant reductions in vigorous exercise. Similar to the pattern observed earlier for any activity, we find that participation in vigorous activity is negatively and significantly associated with the price of gas, but positively associated with bus fare. One explanation is that people misreport walking to the bus as leisure time physical activity. If this is true, we would find the bus fare price to disappear when we examine vigorous physical activity, as walking would not fit this category. We expect tennis to be a larger component of vigorous exercise than any exercise, but we find an unexpected positive correlation between the price of tennis balls and participation in vigorous activity. This may be due to the fact that the price of tennis balls is a small component of the total price of tennis (court fees, time costs, racquet costs). In the pooled sample, and for men, we find a positive and significant association in our measure of the taste for preventative care (getting a flu shot) and engaging in vigorous exercise.

Results for Models of Vigorous and Moderate Exercise

Table 9.7 shows the results when the dependent variable is moderate or vigorous physical activity (PA). The results are generally consistent with the results for only vigorous exercise. For all measures of exercise we consider, we find gyms per capital are positively associated. The measures of recreation facilities per capita are generally positively and significantly associated with engaging in vigorous or moderate exercise. We continue to find that gas prices are associated with less exercise while bus fare has a positive association. Property crime rates are negatively associated with exercise for the pooled sample and men, but there is no significant association with violent crime rates. Cigarette and beer taxes are negative and significant factors (with the exception of the cigarette tax for women). Thus, we find no evidence that individuals change health behaviors together in response to a change in the price of smoking or drinking. Indeed, our results indicate that vigorous physical activity declines as either beer or cigarette taxes increase. The price of tennis balls and bowling have opposite effects on moderate or vigorous physical activity (positive and negative, respectively). The preventive health measure (flu shots) is positive for only for men.

Stratification by Income Category

We report the results stratified by income in tables 9.8, 9.9, and 9.10. While the coefficients of most demographic and socioeconomic variables in the model for participation in any leisure time exercise are stable across income categories, the effects of some variables do change. The effects of being married, retired, or a student or homemaker appear to have a larger impact at lower incomes than higher ones. The effect of being insured is generally positive with stronger effects as income increases. The effects of gender, race variables, and education variables do not appear to vary systematically with income. Based on our earlier findings that physical activity decreases when gas prices are high (or bus fares low), we expected to find stronger price effects at low incomes where prices presumably bite. Instead, we find neither is significant for any income group. The county crime rates generally have a negative effect where significant, but there is no apparent pattern by income. Similarly, exercise and recreation venues per capita are positive when significant, but the effects are nil for most income categories and no pattern emerges. Taxes have no effect for any income category. Flu shots have a robust positive effect across income categories.

9.8 Conclusions

In this chapter we examine factors associated with variation in leisure time physical activity. To explore these associations, we model three levels of leisure time physical activity—any exercise, physical activity that is moderate or vigorous, and vigorous physical activity in the past thirty days. Our

Table 9.7 Participation in moderate or vigorous exercise

	Model 1: Females and males	Model 2: Female	Model 3: Male
Age	–0.0011*	–0.0005*	–0.0018*
	(0.0002)	(0.0002)	(0.0002)
Age squared	–2.37E-06*	–7.04E-06*	4.14E-06*
	(1.6E-06)	(2.0E-06)	(2.0E-06)
Male	0.0072*		
	(0.0009)		
Hispanic	–0.0134*	–0.0134*	–0.0127*
	(0.0019)	(0.0025)	(0.0029)
White	0.0035*	0.0068*	–0.0006
	(0.0017)	(0.0023)	(0.0026)
Black	–0.0127*	–0.0151*	–0.0069
	(0.0024)	(0.0031)	(0.0037)
Asian	–0.0432*	–0.0395*	–0.0471*
	(0.0033)	(0.0045)	(0.0049)
Married	–0.0059*	–0.0042*	–0.0084*
	(0.0009)	(0.0013)	(0.0014)
High school diploma	0.0138*	0.0117*	0.0171*
	(0.0017)	(0.0022)	(0.0026)
Some college	0.0212*	0.0225*	0.0194*
	(0.0018)	(0.0023)	(0.0027)
College degree or more	0.0318*	0.0320*	0.0323*
	(0.0018)	(0.0024)	(0.0027)
Income < $10k	–0.0506*	–0.0495*	–0.0519*
	(0.0024)	(0.0030)	(0.0040)
Income $15k < $20k	–0.0431*	–0.0428*	–0.0430*
	(0.0023)	(0.0029)	(0.0038)
Income $20k < $25k	–0.0382*	–0.0386*	–0.0375*
	(0.0020)	(0.0026)	(0.0032)
Income $25k < $30k	–0.0322*	–0.0333*	–0.0308*
	(0.0018)	(0.0024)	(0.0028)
Income $30k < $35k	–0.0263*	–0.0286*	–0.0237*
	(0.0016)	(0.0021)	(0.0024)
Income $35k < $50k	–0.0198*	–0.0201*	–0.0202*
	(0.0014)	(0.0019)	(0.0021)
Income $50k < $75k	–0.0113*	–0.0123*	–0.0105*
	(0.0013)	(0.0018)	(0.0020)
Unemployed	0.0114*	0.0039	0.0212*
	(0.0021)	(0.0028)	(0.0033)
Student or homemaker	0.0246*	0.0227*	0.0311*
	(0.0015)	(0.0016)	(0.0041)
Retired	0.0273*	0.0263*	0.0271*
	(0.0016)	(0.0021)	(0.0025)
Insured	–0.0054*	–0.0075*	–0.0018
	(0.0014)	(0.0019)	(0.0021)
Price of bowling	–0.0097*	–0.0067*	–0.0137*
	–0.0019	–0.0025	–0.0029
Price of tennis balls	0.0092*	0.0106*	0.0074*
	(0.0017)	(0.0022)	(0.0026)

Table 9.7 (continued)

	Model 1: Females and males	Model 2: Female	Model 3: Male
Price of gas	–0.0386*	–0.0407*	–0.0363*
	(0.0037)	(0.0048)	(0.0056)
Bus fare	0.0165*	0.0101*	0.0247*
	(0.0024)	(0.0031)	(0.0037)
Violent crime rate	0.0004	0.0003	0.0006
	(0.0002)	(0.0003)	(0.0004)
Property crime rate	–0.0001*	–9.56E-05	–0.0002*
	(4.5E-05)	(5.9E-05)	(7.0E-05)
Number of gyms per capita	0.0392*	0.0683*	–0.0003
	(0.0102)	(0.0135)	(0.0156)
Number of parks per capita	0.2600*	0.2130*	0.3300*
	(0.0615)	(0.0809)	(0.0945)
Number of other rec areas per capita	0.0115*	0.0148*	0.0071
	(0.0045)	(0.0059)	(0.0068)
Cigarette tax	–0.0135*	–0.0082	–0.0199*
	(0.0029)	(0.0038)	(0.0045)
Beer tax	–0.1790*	–0.1550*	–0.1850*
	(0.0415)	(0.0551)	(0.0630)
Flu shot	0.0016	–0.0026	0.0071*
	(0.0010)	(0.0013)	(0.0015)
Observations	383,950	222,823	161,127
R^2	0.4	0.386	0.42

Notes: Standard errors in parentheses.

*Significant at the 10 percent level.

preferred specification includes state, year, and month fixed effects, as well as controls for area level recreation amenities, area crime rates, prices for related goods, and a preventive health measure (flu shots).

The estimated effects of socioeconomic factors are robust across model and exercise measure. We find that income has a strong and consistently positive association with physical activity across specifications. Education is also a positive and significant factor in all models, and the effects are fairly stable across gender and income. In almost every model, we find that individuals who report being married are generally associated with decreased participation in physical activity. For any exercise, the effect appears to be driven by those with lower income and women. For vigorous exercise, the effects of marriage are about the same for men and women. Holding marital status constant, men are more likely to exercise than women across all income levels. Individuals who work are less likely to engage in exercise by any measure than those who are unemployed, retired, or out of the labor force, and the effect for any exercise appears to be larger when income is low. To better understand these results, we would like to have better measures of the time constraints affecting men and women including family size, time

Table 9.8 **Participation in any exercise, stratified by income**

	< 10 K	10K– < 20K	20K– < 25K	25K– < 30K	30K– < 35K	35K– < 50K	50K– < 75K	> 75K
Age	–0.0081*	–0.0052*	–0.0031*	–0.0028*	–0.0029*	–0.0022*	–0.0006	0.0002
	(0.0010)	(0.0010)	(0.0008)	(0.0007)	(0.0006)	(0.0005)	(0.0006)	(0.0005)
Age squared	4.59E-05*	1.56E-05	–7.62E-06	–7.98E-06	–5.77E-06	–7.60E-06	–2.34E-05	–2.25E-05*
	(1.0e-05)	(9.3e-06)	(7.0e-06)	(7.0e-06)	(5.9e-06)	(5.7e-06)	(6.1e-06)	(5.2e-06)
Male	0.0371*	0.0300*	0.0342*	0.0259*	0.0166*	0.0170*	0.0225*	0.0218*
	(0.0075)	(0.0071)	(0.0057)	(0.0047)	(0.0036)	(0.0029)	(0.0027)	(0.0021)
Hispanic	–0.0614*	–0.0554*	–0.0644*	–0.0572*	–0.0410*	–0.0330*	–0.0183*	–0.0217*
	(0.0121)	(0.0116)	(0.0099)	(0.0086)	(0.0073)	(0.0067)	(0.0069)	(0.0059)
White	–0.0074	0.0209	0.0078	0.0136	0.0155*	0.0141*	0.0109	0.0190*
	(0.0107)	(0.0108)	(0.0092)	(0.0082)	(0.0069)	(0.0061)	(0.0062)	(0.0052)
Black	–0.0325*	–0.0215	–0.0381*	–0.0536*	–0.0351*	–0.0417*	–0.0272*	–0.0211*
	(0.0145)	(0.0151)	(0.0123)	(0.0112)	(0.0091)	(0.0082)	(0.0086)	(0.0073)
Asian	–0.0257	0.0058	–0.0789*	–0.0673*	–0.0663*	–0.0847*	–0.0800*	–0.0704*
	(0.0248)	(0.0268)	(0.0222)	(0.0189)	(0.0141)	(0.0117)	(0.0105)	(0.0078)
Married	–0.0220*	–0.0212*	–0.0336*	–0.0286*	–0.0204*	–0.0161*	–0.0131*	0.0009
	(0.0091)	(0.0079)	(0.0059)	(0.0047)	(0.0036)	(0.0030)	(0.0030)	(0.0028)
High school diploma	0.0549*	0.0657*	0.0624*	0.0762*	0.0947*	0.0788*	0.0691*	0.0576*
	(0.0087)	(0.0084)	(0.0074)	(0.0070)	(0.0066)	(0.0073)	(0.0089)	(0.0097)
Some college	0.1250*	0.1170*	0.1290*	0.1330*	0.1530*	0.1340*	0.1210*	0.1020*
	(0.0097)	(0.0094)	(0.0081)	(0.0074)	(0.0067)	(0.0072)	(0.0088)	(0.0096)
College degree or more	0.1840*	0.1750*	0.1850*	0.1850*	0.1980*	0.1780*	0.1640*	0.1440*
	(0.0122)	(0.0118)	(0.0098)	(0.0084)	(0.0071)	(0.0073)	(0.0087)	(0.0094)
Unemployed	0.0659*	0.0705*	0.0288*	0.0242*	0.0027	–0.0028	–0.0216*	–0.0090
	(0.0102)	(0.0118)	(0.0101)	(0.0093)	(0.0090)	(0.0082)	(0.0085)	(0.0074)
Student or homemaker	0.110*	0.0755*	0.0560*	0.0558*	0.0352*	0.0248*	0.0281*	0.0194*
	(0.0104)	(0.0106)	(0.0089)	(0.0078)	(0.0064)	(0.0053)	(0.0050)	(0.0036)
Retired	0.0973*	0.1050*	0.0913*	0.0758*	0.0788*	0.0648*	0.0619*	0.0286*
	(0.0115)	(0.0102)	(0.0090)	(0.0076)	(0.0062)	(0.0055)	(0.0057)	(0.0047)

Insured	–0.0130	–0.0077	0.0071	0.0101	0.0119*	0.0180*	0.0236*	0.0363*
	(0.0082)	(0.0081)	(0.0066)	(0.0058)	(0.0051)	(0.0051)	(0.0061)	(0.0061)
Price of bowling	–0.0272	0.0117	–0.0211	0.0108	0.0056	0.0084	–0.0081	–0.0045
	(0.0161)	(0.0149)	(0.0125)	(0.0104)	(0.0079)	(0.0064)	(0.0057)	(0.0044)
Price of tennis balls	–0.0138	–0.0032	–0.0236*	0.0155	–0.0033	–0.0023	0.0063	–0.0053
	(0.0136)	(0.0129)	(0.0107)	(0.0089)	(0.0068)	(0.0056)	(0.0051)	(0.0041)
Price of gas	0.0089	–0.0290	–0.0213	–0.0316	0.0025	–0.0168	–0.0138	–0.0011
	(0.0289)	(0.0275)	(0.0232)	(0.0194)	(0.0149)	(0.0123)	(0.0113)	(0.0090)
Bus fare	–0.0002	0.0277	0.0232	0.0236	0.0109	0.0136	0.0118	0.0084
	(0.0206)	(0.0194)	(0.0155)	(0.0134)	(0.0103)	(0.0083)	(0.0074)	(0.0053)
Violent crime rate	0.0042*	–0.0021	–0.0021	0.0009	–0.0022*	0.0006	–0.0018*	–0.0013*
	(0.0017)	(0.0017)	(0.0014)	(0.0012)	(0.0009)	(0.0008)	(0.0008)	(0.0006)
Property crime rate	–0.0007	0.0003	0.0001	–0.0006	0.0001	–0.0001	0.0001	0.0002
	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Number of gyms per capita	0.0219	0.0086	0.1060	0.1660*	0.0393	0.0944*	0.1290*	0.1210*
	(0.0790)	(0.0773)	(0.0639)	(0.0525)	(0.0414)	(0.0345)	(0.0322)	(0.0257)
Number of parks per capita	0.2910	0.1700	0.7310	0.3370	0.3250	0.1350	0.3150	0.0661
	(0.4790)	(0.4410)	(0.3880)	(0.3130)	(0.2370)	(0.1940)	(0.1990)	(0.1690)
Number of other rec areas per capita	0.0319	0.0070	–0.0017	0.0375	0.0431*	0.0443*	0.0205	0.0150
	(0.0371)	(0.0335)	(0.0275)	(0.0228)	(0.0176)	(0.0145)	(0.0137)	(0.0118)
Cigarette tax	–0.0031	0.0319	–0.0223	–0.0209	–0.0018	–0.0009	–0.0144	–0.0043
	(0.0240)	(0.0224)	(0.0183)	(0.0157)	(0.0120)	(0.0099)	(0.0090)	(0.0067)
Beer tax	0.1480	0.2540	–0.3370	–0.1280	0.2700	–0.0513	0.0346	–0.0433
	(0.3440)	(0.3200)	(0.2560)	(0.2190)	(0.1680)	(0.1360)	(0.1270)	(0.1050)
Flu shot	–0.0032	0.0130	0.0182*	0.0149*	0.0114*	0.0147*	0.0167*	0.0074*
	(0.0078)	(0.0074)	(0.0062)	(0.0052)	(0.0040)	(0.0033)	(0.0030)	(0.0023)
Observations	18,493	20,360	28,299	37,409	55,354	70,065	69,079	84,891
R^2	0.195	0.188	0.213	0.24	0.301	0.348	0.393	0.465

Notes: Standard errors in parentheses.
*Significant at the 10 percent level.

Table 9.9 **Participation in vigorous exercise, stratified by income**

	< 10 K	10K–20K	20K– < 25K	25K– < 30K	30K– < 35K	35K– < 50K	50K– < 75K	> 75K
Age	–0.0045*	–0.0034*	–0.0031*	–0.0030*	–0.0025*	–0.0019*	–0.0018*	–0.0016*
	(0.0004)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
Age squared	3.32E-05*	2.08E-05*	1.82E-05*	1.60E-05*	1.03E-05*	1.90E-06	3.43E-06	–7.14E-07
	(4.1e-06)	(3.8e-06)	(3.5e-06)	(3.3e-06)	(3.1e-06)	(3.4e-06)	(4.2e-06)	(4.5e-06)
Male	0.0155*	0.0186*	0.0192*	0.0177*	0.0199*	0.0151*	0.0178*	0.0146*
	(0.0030)	(0.0029)	(0.0025)	(0.0023)	(0.0019)	(0.0018)	(0.0018)	(0.0018)
Hispanic	–0.0091	–0.0109*	–0.0162*	–0.0125*	–0.0113*	–0.0027	0.0038	0.0033
	(0.0049)	(0.0047)	(0.0043)	(0.0041)	(0.0039)	(0.0041)	(0.0048)	(0.0050)
White	0.0071	0.0050	0.0029	–0.0001	–0.0122*	–0.0064	–0.0036	–0.0024
	(0.0044)	(0.0044)	(0.0040)	(0.0039)	(0.0037)	(0.0037)	(0.0043)	(0.0045)
Black	0.0040	–0.0081	–0.0084	–0.0115*	–0.0185*	–0.0098*	–0.0023	–0.0083
	(0.0059)	(0.0061)	(0.0054)	(0.0053)	(0.0049)	(0.0050)	(0.0059)	(0.0063)
Asian	–0.0240*	–0.0225*	–0.0289*	–0.0439*	–0.0379*	–0.0408*	–0.0331*	–0.0465*
	(0.0101)	(0.0109)	(0.0097)	(0.0090)	(0.0075)	(0.0071)	(0.0073)	(0.0067)
Married	–0.0054	–4.74E-05	–0.0018	–0.0031	–0.0066*	–0.0119*	–0.0143*	–0.0088*
	(0.0037)	(0.0032)	(0.0026)	(0.0023)	(0.0019)	(0.0018)	(0.0021)	(0.0024)
High school diploma	0.0063	0.0033	0.0077*	0.0088*	0.0038	0.0066	0.0061	0.0158
	(0.0036)	(0.0034)	(0.0032)	(0.0033)	(0.0035)	(0.0044)	(0.0061)	(0.0083)
Some college	0.0170*	0.0126*	0.0168*	0.0172*	0.0091*	0.0133*	0.0149*	0.0258*
	(0.0040)	(0.0038)	(0.0036)	(0.0035)	(0.0036)	(0.0044)	(0.0061)	(0.0082)
College degree or more	0.0355*	0.0218*	0.0269*	0.0273*	0.0190*	0.0229*	0.0264*	0.0423*
	(0.0050)	(0.0048)	(0.0043)	(0.0040)	(0.0038)	(0.0044)	(0.0060)	(0.0081)
Unemployed	0.0055	0.0195*	–0.0001	0.0062	0.0031	0.0075	0.0097	0.0044
	(0.0042)	(0.0048)	(0.0044)	(0.0044)	(0.0048)	(0.0050)	(0.0059)	(0.0063)
Student or homemaker	0.0207*	0.0144*	0.0122*	0.0107*	0.0068*	0.0072*	0.0176*	0.0139*
	(0.0042)	(0.0043)	(0.0039)	(0.0037)	(0.0034)	(0.0032)	(0.0034)	(0.0031)

Retired	0.0079	0.0090*	0.0076	0.0090*	0.0073*	0.0164*	0.0109*	0.0135*
	(0.0047)	(0.0041)	(0.0039)	(0.0036)	(0.0033)	(0.0033)	(0.0039)	(0.0040)
Insured	–0.0052	–0.0049	–0.0059*	–0.0051	0.0027	–0.0036	0.0029	0.0023
	(0.0034)	(0.0033)	(0.0029)	(0.0028)	(0.0027)	(0.0031)	(0.0042)	(0.0052)
Price of bowling	0.0043	0.0004	–0.0162*	–0.0017	–0.0109*	–0.0027	–0.0038	–0.0013
	(0.0066)	(0.0061)	(0.0055)	(0.0050)	(0.0042)	(0.0039)	(0.0040)	(0.0037)
Price of tennis balls	–0.0002	–0.0006	0.0062	0.0000	0.0060	0.0059	0.0032	0.0067
	(0.0056)	(0.0052)	(0.0047)	(0.0043)	(0.0036)	(0.0034)	(0.0036)	(0.0035)
Price of gas	–0.0289*	–0.0224*	–0.0278*	–0.0156	–0.0331*	–0.0269*	–0.0184*	–0.0231*
	(0.0118)	(0.0112)	(0.0101)	(0.0093)	(0.0080)	(0.0075)	(0.0078)	(0.0077)
Bus fare	0.0152	0.0204*	0.0205*	0.0173*	0.0211*	0.0122*	0.0142*	0.0194*
	(0.0084)	(0.0079)	(0.0068)	(0.0064)	(0.0055)	(0.0050)	(0.0051)	(0.0045)
Violent crime rate	0.0002	–0.0010	0.0008	0.0007	0.0000	0.0005	–0.0006	–0.0001
	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Property crime rate	–0.0001	0.0001	–0.0002	–0.0002*	0.0000	0.0000	0.0001	0.0000
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of gyms per capita	0.0249	–0.0238	0.0131	–0.0283	0.0300	–0.0016	0.0779*	0.0265
	(0.0322)	(0.0314)	(0.0280)	(0.0251)	(0.0221)	(0.0208)	(0.0222)	(0.0219)
Number of parks per capita	0.1150	0.2410	0.1380	0.0659	0.0731	0.1440	–0.1010	–0.1010
	(0.1950)	(0.1790)	(0.1700)	(0.1490)	(0.1260)	(0.1170)	(0.1370)	(0.1450)
Number of other rec areas per capita	0.0214	0.0168	0.0048	–0.0052	0.0043	0.0067	0.0257	0.0249*
	(0.0151)	(0.0136)	(0.0120)	(0.0109)	(0.0094)	(0.0088)	(0.0095)*	(0.0101)
Cigarette tax	0.0182	–0.0024	–0.0103	–0.0001	–0.0182*	–0.0101	–0.0118	–0.0128*
	(0.0098)	(0.0091)	(0.0080)	(0.0075)	(0.0064)	(0.0060)	(0.0062)	(0.0058)
Beer tax	–0.0954	–0.0429	–0.0875	–0.0438	–0.0481	–0.1450	–0.1130	–0.2600*
	(0.1400)	(0.1300)	(0.1120)	(0.1040)	(0.0897)	(0.0824)	(0.0876)	(0.0898)
Flu shot	–0.0010	0.0034	–0.0030	–0.0012	0.0023	0.0038	0.0009	0.0037
	(0.0032)	(0.0030)	(0.0027)	(0.0025)	(0.0022)	(0.0020)	(0.0021)	(0.0019)
Observations	18,493	20,360	28,299	37,409	55,354	70,065	69,079	84,891
R^2	0.143	0.137	0.152	0.169	0.194	0.216	0.246	0.296

Notes: Standard errors in parentheses.
*Significant at the 10 percent level.

Table 9.10 **Participation in moderate or vigorous exercise, stratified by income**

	< 10 K	10K– < 20K	20K– < 25K	25K– < 30K	30K– < 35K	35K– < 50K	50K– < 75K	> 75K
Age	–0.0034*	–0.0022*	–0.0018*	–0.0015*	–0.0009*	–0.0005	–0.0002	–0.0002
	(0.0006)	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
Age squared	1.91E-05*	1.07E-05*	5.38E-06	7.21E-07	–4.56E-06	–7.77E-06*	–8.39E-06	–9.47E-06*
	(5.6E-06)	(5.2E-06)	(4.6E-06)	(4.2E-06)	(3.7E-06)	(3.9E-06)	(4.7E-06)	(4.6E-06)
Male	0.0126*	0.0116*	0.0120*	0.0108*	0.0116*	0.0045*	0.0054*	0.0020
	(0.0041)	(0.0039)	(0.0033)	(0.0028)	(0.0023)	(0.0020)	(0.0020)	(0.0018)
Hispanic	–0.0191*	–0.0178*	–0.0248*	–0.0222*	–0.0163*	–0.0064	0.0055	–0.0103*
	(0.0067)	(0.0064)	(0.0056)	(0.0052)	(0.0047)	(0.0047)	(0.0052)	(0.0053)
White	0.0168*	0.0174*	0.0114*	0.0034	–0.0063	–0.0052	0.0042	–0.0075
	(0.0059)	(0.0060)	(0.0052)	(0.0049)	(0.0044)	(0.0042)	(0.0047)	(0.0047)
Black	0.0003	–0.0052	–0.0185*	–0.0170*	–0.0245*	–0.0170*	–0.0052	–0.0290*
	(0.0080)	(0.0083)	(0.0070)	(0.0067)	(0.0058)	(0.0057)	(0.0065)	(0.0065)
Asian	–0.0023	–0.0211	–0.0355*	–0.0567*	–0.0411*	–0.0489*	–0.0435*	–0.0606*
	(0.0137)	(0.0148)	(0.0126)	(0.0113)	(0.0090)	(0.0081)	(0.0080)	(0.0070)
Married	–0.0083	–0.0008	–0.0047	–0.0033	–0.0022	–0.0084*	–0.0100*	–0.0075*
	(0.0051)	(0.0043)	(0.0033)	(0.0028)	(0.0023)	(0.0021)	(0.0023)	(0.0025)
High school diploma	0.0177*	0.0102*	0.0090*	0.0138*	0.0136*	0.0111*	–0.0003	0.0206*
	(0.0048)	(0.0047)	(0.0042)	(0.0042)	(0.0042)	(0.0050)	(0.0067)	(0.0087)
Some college	0.0314*	0.0204*	0.0235*	0.0231*	0.0156*	0.0172*	0.0082	0.0267*
	(0.0054)	(0.0052)	(0.0046)	(0.0044)	(0.0043)	(0.0050)	(0.0066)	(0.0085)
College degree or more	0.0421*	0.0258*	0.0294*	0.0331*	0.0261*	0.0264*	0.0180*	0.0403*
	(0.0068)	(0.0065)	(0.0056)	(0.0050)	(0.0045)	(0.0051)	(0.0066)	(0.0084)
Unemployed	0.0190*	0.0285*	0.0059	–0.0003	0.0066	0.0150*	0.0113	0.0135*
	(0.0057)	(0.0065)	(0.0058)	(0.0055)	(0.0057)	(0.0057)	(0.0064)	(0.0066)
Student or homemaker	0.0273*	0.0245*	0.0159*	0.0162*	0.0209*	0.0219*	0.0275*	0.0268*
	(0.0058)	(0.0059)	(0.0051)	(0.0046)	(0.0041)	(0.0037)	(0.0038)	(0.0032)
Retired	0.0277*	0.0136*	0.0136*	0.0214*	0.0251*	0.0372*	0.0349*	0.0306*
	(0.0064)	(0.0056)	(0.0051)	(0.0046)	(0.0039)	(0.0038)	(0.0043)	(0.0041)

Insured	–0.0086	–0.0131*	–0.0068	–0.0060	–0.0008	–0.0071*	–0.0037	0.0040
	(0.0046)	(0.0045)	(0.0038)	(0.0035)	(0.0032)	(0.0035)	(0.0047)	(0.0054)
Price of bowling	–0.0124	–0.0081	–0.0386*	–0.0029	–0.0226*	–0.0089*	–0.0088*	–0.0103*
	(0.0089)	(0.0082)	(0.0071)	(0.0062)	(0.0051)	(0.0044)	(0.0043)	(0.0039)
Price of tennis balls	0.0022	0.0006	0.0010	0.0045	0.0100*	0.0123*	0.0074	0.0075*
	(0.0076)	(0.0071)	(0.0061)	(0.0053)	(0.0043)	(0.0039)	(0.0039)	(0.0036)
Price of gas	–0.0481*	–0.0299*	–0.0587*	–0.0469*	–0.0496*	–0.0477*	–0.0344*	–0.0322*
	(0.0160)	(0.0152)	(0.0132)	(0.0116)	(0.0095)	(0.0085)	(0.0086)	(0.0080)
Bus fare	0.0355*	0.0407*	0.0333*	0.0084	0.0287*	0.0166*	0.0198*	0.0211*
	(0.0114)	(0.0107)	(0.0088)	(0.0080)	(0.0066)	(0.0057)	(0.0056)	(0.0047)
Violent crime rate	0.0016	–0.0019*	0.0008	0.0005	0.0011	0.0004	–0.0004	0.0005
	(0.0010)	(0.0009)	(0.0008)	(0.0007)	(0.0006)	(0.0005)	(0.0006)	(0.0005)
Property crime rate	–0.0003	0.0001	–0.0001	–0.0002	–0.0003*	–0.0001	–5.66E-06	–0.0002
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Number of gyms per capita	0.0275	0.0171	0.0122	–0.0225	0.0710*	0.0139	0.0719*	0.0040
	(0.0438)	(0.0426)	(0.0364)	(0.0314)	(0.0264)	(0.0239)	(0.0244)	(0.0228)
Number of parks per capita	0.1050	0.0501	0.5080*	0.4150*	0.2640	0.1800	0.3930*	0.2080
	(0.2650)	(0.2430)	(0.2210)	(0.1870)	(0.1510)	(0.1350)	(0.1510)	(0.1500)
Number of other rec areas per capita	0.0114	0.0045	0.0078	–0.0090	0.0059	0.0119	0.0211*	0.0199
	(0.0206)	(0.0184)	(0.0156)	(0.0136)	(0.0112)	(0.0101)	(0.0104)	(0.0105)
Cigarette tax	–0.0128	–0.0129	–0.0157	0.0005	–0.0245*	–0.0130	–0.0127	–0.0144*
	(0.0133)	(0.0123)	(0.0104)	(0.0094)	(0.0077)	(0.0069)	(0.0068)	(0.0060)
Beer tax	–0.3780*	–0.1830	–0.2430	–0.0527	–0.0647	–0.2210*	–0.0993	–0.1990*
	(0.1910)	(0.1760)	(0.1460)	(0.1310)	(0.1070)	(0.0945)	(0.0962)	(0.0934)
Flu shot	–0.0010	0.0033	–0.0047	–0.0017	0.0056*	0.0013	0.0010	0.0019
	(0.0043)	(0.0041)	(0.0035)	(0.0031)	(0.0026)	(0.0023)	(0.0023)	(0.0020)
Observations	18,493	20,360	28,299	37,409	55,354	70,065	69,079	84,891
R^2	0.291	0.296	0.318	0.345	0.373	0.405	0.442	0.482

Notes: Standard errors in parentheses.
*Significant at the 10 percent level.

at work, commuting time, and time in other activities. Unfortunately, the BRFSS does not have a consistent measure of family size across the years of our data, nor does it contain any time use measures.

The effects of area-specific variables are also largely consistent across our specifications. These coefficients must be interpreted with caution because individuals who are likely to exercise may choose to live in areas with certain amenities and characteristics. We do not find that exercise levels vary with the two direct "own" price measures (price of tennis balls and price of bowling balls), but we do find a significant association between transportation costs and exercise. Gas prices are negatively and significantly related to leisure time exercise while bus fare is positive and significantly associated in most models of participation in any leisure time exercise or vigorous exercise. Contrary to what we might have expected, the effects of gas and bus fare do not differ by income. Individuals who are on the margin for exercising may be the ones who drive to an exercise venue and are deterred by the increased cost of transportation. The positive association with bus fare suggests that individuals do not take the bus to the gym or other exercise venue, but instead use the bus to access leisure time substitutes for physical activity. The results may also point to problems in the way physical activity is measured in the BRFSS. While the survey question specifies leisure time exercise, respondents may include transportation exercise (for example, walking to work) as part of this response. Another concern is the merging of the price data is at too gross of a level. Price and area measures may need to be at a census tract or lower area level, which is not available on this data set.

Sin taxes have no effect on the likelihood of any exercise, but generally have negative effects on vigorous exercise or moderate and vigorous exercise. These results suggest inactivity and smoking (or drinking) may be substitutes. People who are forced to become healthier in one dimension due to the higher taxes may be able to relax their health behaviors in another area and still keep health stock at the target level.

We find a weak association between violent crimes and participation in exercise and no effect from property crime rates. Physical activity is positively associated with areas where there are more parks per capita in a county, which is consistent with Humphrey and Ruseki's (2007) findings using state-level variation in total state, and local spending on parks is positively associated with outdoor activity.

Our earlier results are robust to the inclusion of use of flu shots. Individuals who get flu shots are generally more likely to report some exercise. While this measure is likely endogenous, we find that its inclusion does not affect the other results. If the area variables earlier were measuring the reverse causation that people who are active and have a higher taste for health preventions move to areas with low crime rates and high spending on parks, then we might expect that adding measures of taste for preventive medicine would reduce the effects of these variables. We consistently find that flu shots

is positively associated with physical activity, indicating that people with higher tastes for prevention may bundle their preventive activities or treat them as complements.

Our results can be compared to Rashad's (2006) analysis of cycling rates using the 1996 to 2000 BRFSS data, and Humphrey and Ruseki's analysis of participation in five categories of leisure time physical activity (outdoor recreation, household activities, group sport, individual sport and walking) using the 1998 and 2000 BRFSS. While our demographic results are largely consistent with both studies, the Humphrey and Ruseki study shows that demographic effects can differ widely across physical activity categories.

The most important limitation in our study is due to the measures of physical activity. The BRFSS measure is based on self-report, and more precise physical activity measures are not consistently reported in every year of the survey. In addition, physical activity measures are not consistently reported in national health surveys, making it difficult to directly compare results. In addition, the most consistent physical activity variable (any exercise) does not conform to the CDC definitions for physical activity. The CDC measures of moderate or vigorous activity (which do conform to measures) are only captured in odd years, and thus, only in three years of our data. The results are also limited to analyzing only leisure time physical activity. Any physical activity is beneficial and future studies need to include measure of activity for transportation and work. Our future work will examine the effects of area variables on other data sets, such as the National Health Interview Survey, to examine more appropriate definitions of physical activity. In addition, measures of park access gym data are at the county level, which may be too large of a geographical dimension to capture the causal impact of increased access. Studies such as Sandy et al. (chapter 7, in this volume) that allow detailed description of the neighborhood may be more appropriate. We are also missing measures of home exercise such as purchasing of exercise equipment or videos that may influence leisure time activity. Finally, we do not have the ability to control for selection of individuals into areas. As people with preferences for exercise and health prevention may locate near amenities such as parks, gyms, or lower crime rates, future research should include the selection into neighborhood decision in their models relating physical activity and area characteristics.

9.9 Policy Implications

The strong relationship we find between education and exercise suggests that there may be positive spillovers from policies aimed at increasing educational attainment. Education aimed at increasing the awareness of the value of physical activity in the form of Public Service Announcements as advocated by Pratt et al. (2004) should be explored further. We also find income

is positively associated with exercise. Our results also show that working individuals are less likely to exercise than those who are unemployed or out of the labor force, and that men are more likely to exercise than women. These reflect the importance of the time constraint in physical activity. Policies aimed to allow more time or flexibility in time may improve leisure time physical activity. Greater flexibility in working hours, increasing the use of telecommuting, providing job site exercise opportunities, and increasing access to childcare are all possible avenues for promoting physical activity through lowered time constraint. Designing appropriate policies will require a better understanding of how time constraints, income, education, and gender interact in determining physical activity. Two recent papers looking at time use (Mullahy and Rober 2008) and time constraints (Loh 2009) are important first steps in this analysis.

We find that certain area characteristics such as access to gyms, parks, and other recreational facilities are associated with an increase in exercise for adults. These effects remain consistent even when we include measures for unobservable tastes for prevention, such as flu shots. We do not find that these results are robust to income stratification, thus recreation stamps to subsidize the low income to attend gyms as advocated by Pratt et al. (2004) may not improve the amount of leisure time physical activity for low-income groups.

Finally, further investigation is warranted on the interaction between various health behaviors. While there are contradictory findings about the association between smoking and obesity (Chou, Grossman, and Saffer 2004, 2006; Gruber and Frakes 2006; Cawley et al. 2003), our findings suggest that smoking and physical activity may be substitutes, and would be consistent with increased obesity due to higher cigarette taxes/prices. Future research should examine the interaction between smoking, alcohol consumption, dietary behavior, and physical activity.

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