The Role of Income in Determining Leisure Time Exercise: A Cross-sectional Study

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Abstract

The obesity epidemic is increasingly dangerous to poor people and racial minorities. This paper uses the most recent National Health and Nutrition Examination Survey (NHANES), a cross sectional survey, to study the effects of socioeconomic characteristics on the amount of leisure time exercise US residents perform. Both TOBIT and Heckman sample selection were used to model the relationship. Increases in income consistently increased amount of exercise done. Whites do more exercise than Blacks or Hispanics, and men do more exercise than women. People do around 20 minutes less of exercise for every year they age. Marital status does not seem to be a determinant of how much exercise Americans do.

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Introduction

Americans are fatter than ever (CDC [2002]). Unfortunately, lower income families and minorities are the most severely hit by the obesity problem. This leads researchers to investigate how socioeconomic circumstances affect a person's ability to control their weight. This paper focuses on studying how income and other individual characteristics influence the time an individual dedicates to exercising.

The most recent survey from the U.S. Centers for Disease Control (CDC) showed that, in 2002, about 65 percent of Americans were overweight or obese (CDC [2002]). Obesity is now the second highest cause of preventable deaths after smoking (McGinnis and Foege [1993]). Some studies suggest that obesity will soon overtake smoking as the number one killer (CDC [2002]).

It is widely accepted that obesity is a very complex disease. Many factors affect weight, such as genetic endowment, nutrition, and life-style among others. Although obesity has many causes, most experts would agree that a healthy diet and exercise are the main solutions to controlling this condition.

The scientific community is constantly looking for ways to deal with this global epidemic. Socioeconomic studies of obesity in the United States have found that poor people are more likely to be obese than people with higher in-come (Zagorsky [2005]). Obesity is also problem among racial minorities (Cawley [2004]). These circumstances make obesity a top priority for our government and scientific communities. It also suggests that dealing with social and economic inequality can help address the problem.

Although the topic of income and exercise is fairly new, the next section will discuss some of the literature on obesity and the socioeconomic factors that affect it. Section 2 will discuss the theoretical background linking income and obesity. Section 3 will discuss the data source (NHANES) and offer some descriptive statistics. Section 4 will discuss the model and the econometric tools to be used. Section 5 will present the results. The last section will offer a conclusion and mention some remaining questions that could be examined.

1. Literature review

Obesity is measured in terms of Body Mass Index (BMI)[1]. Guidelines set out by the Centers for Disease Control (CDC) and other medical institutions are as follows:

Table 1: BMI

BMI		Condition
0	- 18.5	Underweight
18.6	- 24.9	Healthy Weight
25	- 29.9	Overweight
30	- 34.9	Obese
35 and up		Severely Obese

Obesity adversely affects a person's health in many ways. It has been associated with heart problems, cancer, diabetes and other serious diseases (Must et al. [1999], Mokdad et al.). It also affects women in several additional ways (NIDDKD [1996]). Even children have been found to have problems stemming from obesity (Freedman et al. [1999]).

Obesity is growing rapidly in America[2] (Figure 1). In 2000, 400,000 deaths were attributed to obesity (Grossman et al. [2005]).

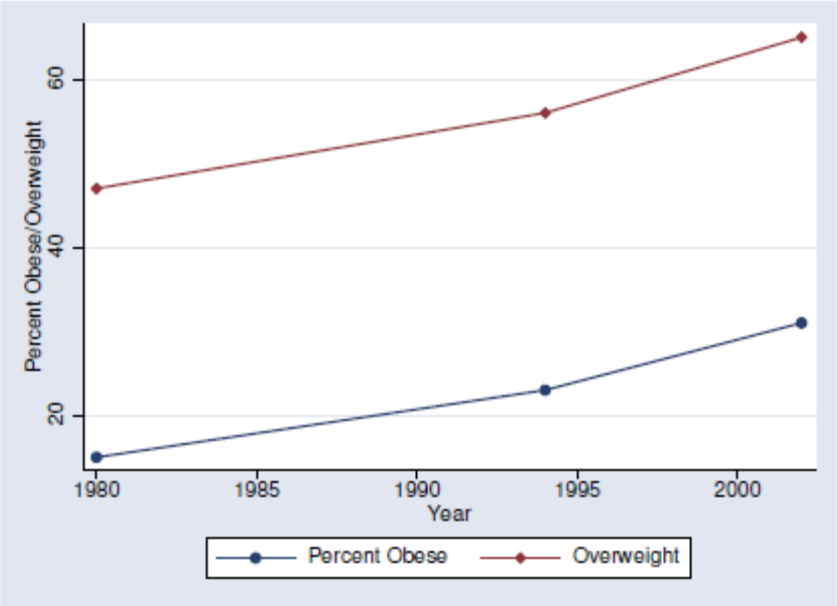
Although genetics play an important role in metabolic functions and diseases, it has been shown that genetics cannot be the sole problem of this epidemic because the gene pool does not change that quickly (Koplan and Dietz [1999]). This leaves two factors that should be studied to help stop this epidemic: caloric intake and expenditure.

Caloric intake has risen in the last 30 years. In 1978 the average American consumed 1,854 calories per day while in the mid-1990s consumption had risen to 2,002 calories (Frazao [1999]). The consumption of fatty foods has also increased (Ippolito and Mathios [1995], Frazao [1999]). Some suggest that the number of per-capita restaurants have increased the caloric content of meals and therefore obesity (Grossman et al. [2005]). Some people have even studied the addictive nature of food and how it leads to an increase in the demand for calories (Cawley [1999]). These factors combined with a decline in food prices (Lakdawalla and Philipson [2002]) have caused an increase in caloric intake.

[1] BMI is calculated by dividing a person's weight by their height squared and therefore has units of $\frac{kg}{m^2}$

[2] Source CDC: NHANES I,II,III

Figure 1: Weight Trends



Caloric expenditure is also a topic of attention in the literature. Some people believe that new modern lifestyles lead to lower caloric expenditure. Activities like walking to work and exercise, which are decreasing because of urban sprawl, are leading factors (Ewing et al. [2003]). Another reason is a decrease in job strenuousness or the physical effort associated with your profession (Philipson [2001], Lakdawalla and Philipson [2002]).

The study of caloric expenditure through leisure time exercise is quite recent. Some papers have included exercise as a way to adjust caloric intake (Rashad [2005]). There are also several Medical papers that study the trends of exercise and physical activity (Hill et al. [2004], Sturm [2004]).

This paper will be one of the few that will give econometric substance to caloric expenditure through voluntary exercise. It will present the links be-tween socioeconomic factors and exercise and will focus on income as the main explanatory variable.

2. Conceptual Framework

People gain happiness and satisfaction from being healthy. Although a person cannot buy health, he can make investments in health (Grossman [1972]). A utility-maximizing individual faces a choice between investing in his health (H) and consuming other goods (C).

$$\max \textit{utility} = U(C, H) \tag{1}$$

He chooses what combination of income and time to spend on improving or maintaining his health and how much to allocate to other goods. His choices, as usual are subject to time and budget constraints.

$$24 = t_l + t_w \quad (2)$$

$$Income = Y = (24 - t_l) \cdot w > C \cdot p + H \cdot q \quad (3)$$

(w = wage, t_l = hours of leisure time, t_w = hours of working time, p = price of consumption goods, and q = price of health goods.)

Health is a function of many things, in mathematical terms it can be represented as a vector. This vector's elements can be examined in trying to ascertain whether a person is healthy or not. One of these variables is weight, which affects other elements of an individual's health such as blood pressure and blood sugar levels (Must et al. [1999], Mokdad et al.). Although many of the following arguments hold for different health conditions this paper will focus its attention on weight.

Weight is a function of caloric intake and caloric expenditure among with an individual's genetic traits. People gain weight if they consume more calories than they expend and lose weight if the opposite occurs. A person's weight is the accumulation of these net caloric balances (caloric intake (CI) – expenditure (CE) over their lifetime (Rashad [2005]),

$$BMI = \sum_t CI_t - CE_t$$

Although some factors that affect weight and obesity cannot be controlled, like genes for example, there are others who can. A person who wishes to lower their weight can either, lower their caloric intake (diet), increase their caloric expenditure (exercise), or both.

Not all individuals consume the same foods or expend energy the same way. Factors like education, age, and income affect how many calories are in a person's meal and what activities he does that burn these calories. In other words a person's socioeconomic situation can affect caloric balance and the way they might diet or exercise.

Exercise is a powerful and popular way to fight weight increases. Unfortunately it is both time- and income-consuming. Health experts have recently recommended that people should exercise for at least an hour three times a week (USDHHS [2000]). A lot of exercise facilities, like gyms, involve high costs in today's world.

It is clear that a person's income and time availability will have an effect on exercise. From equation (3) it can be observe that, $\partial Y/\partial t_l < 0$. This means that an increase in leisure time, in this case exercise, decreases your income. It also can be seen from (3) that $\partial H/\partial Y_l < 0$ in other words more income allows people to spend more money in exercise. This suggests that when studying the effect of income on exercise it is important to understand that the effect of income on exercise is theoretically ambiguous. A person with more income can afford a gym but his opportunity cost of exercising is higher than a poorer individual.

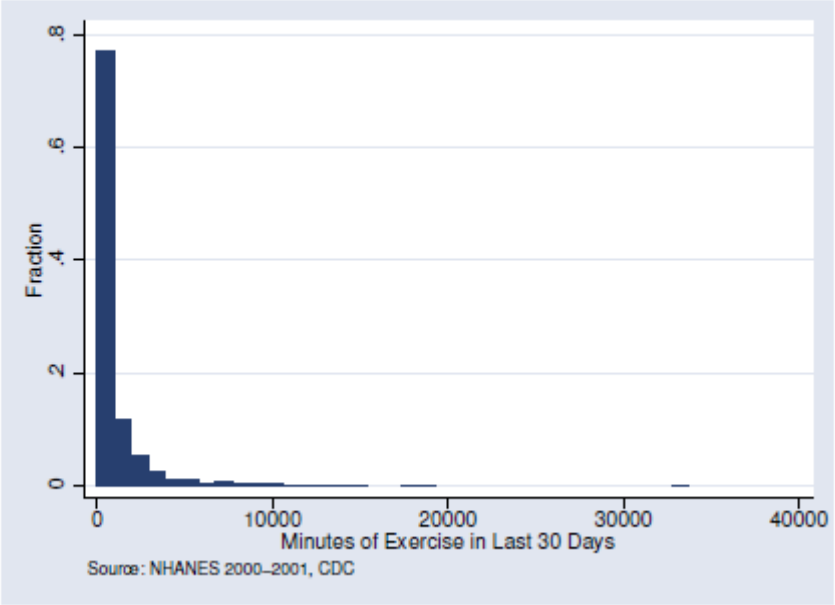
In the next sections this paper will provide the data set, empirical model, and econometric tools that will be used to measure the effect of income on exercise.

3. Data

For this paper the data set used is the National Health and Nutrition Examination Survey (NHANES) from 2001-2002. This is a large cross-sectional survey conducted by the Centers for Disease Control (CDC). For this study data is used for individuals 30 years of age and older yielding around 4,000 observations. It focuses only on individuals 30 years or older because they usually have completed their education and are more likely to participate in the workforce. This data set provided me with the minutes of exercise done in the past 30 days for each individual. It also provided information about the income group and socioeconomic conditions for each person. This information consisted of age, marital status, gender, race and education.

The exercise variable had a minimum value of 0 and a maximum value of 33,720. Forty seven percent of the individuals did no exercise. Almost 80 percent of the individuals did 1,000 or less minutes of exercise. Figure 2 shows the distribution of our dependent variable.

Figure 2: Exercise Distribution



The data provides income in 11 groups which this paper followed. Table 2 shows these ranges and Figure 3 shows the percent of individuals in each income group.

Table 2: Income Groups

Group	Income Range
1	$0 - $4,999
2	$5,000 - $9,999
3	$10,000 - $14,999
4	$15,000 - $19,999
5	$20,000 - $24,999
6	$25,000 - $34,999
7	$35,000 - $44,999
8	$45,000 - $54,999
9	$55,000 - $64,999
10	$65,000 - $74,999
11	$75,000 - over

Socioeconomic variables were classified the following way[3]. Age was measured in years. Individuals were classified by these racial groups, non-Hispanic white, non-Hispanic black, Hispanic, and others. Education was measured in 2 categories, no college or at least some college[4]. Individuals were also grouped as male or female and married or not married. Table 3 shows the classification and distribution of the other socioeconomic variables.

Table 3: Descriptive Statistics N=3921

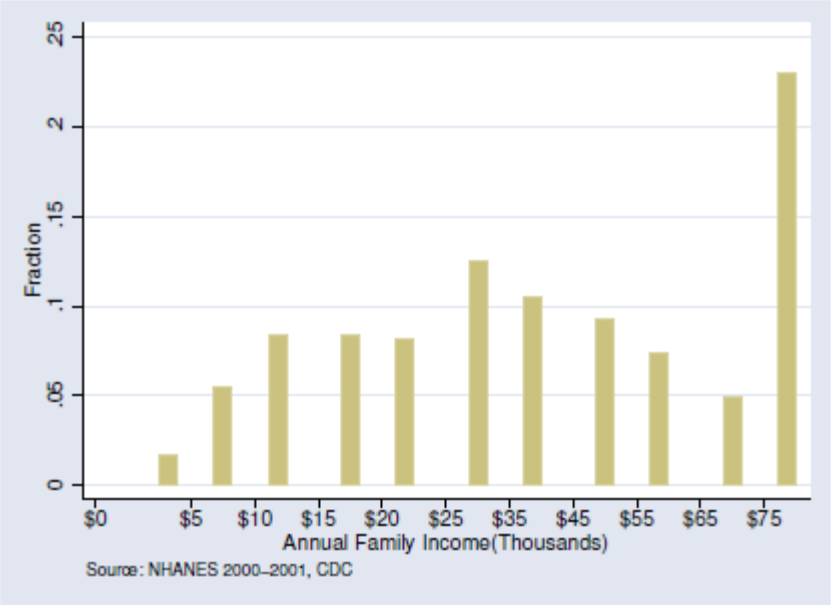
Variable	Distribution
Percentage of people who did some exercise	53%
Minutes of exercise in last 30 days	741 (1571.88)
Age in years	56 (16.60)
Male	48.9 %
Female	51.1 %
Married	62%
Non-Married	38%
No college	54%
Some college	46%
White non-Hispanic	56.31%
Black non-Hispanic	18.11%
Hispanic	22.34%
Other	3.24%

[3] Some variable categories were grouped so that our omitted group was significant. For the scope of this paper it was more important to have a comparatively useful omitted group than distinguishing, for example, between Separated or Divorced.

[4] This includes college graduates.

This paper will study how income and the other socioeconomic explanatory variables help explain the amount of exercise Americans do. Figure 4 gives further evidence of what the literature and theory suggest that individuals with more income have more access to exercise facilities and can do more exercise. In the following section it will describe the model to be used in this project.

Figure 3: Income Distribution



4. Model and Econometric tools

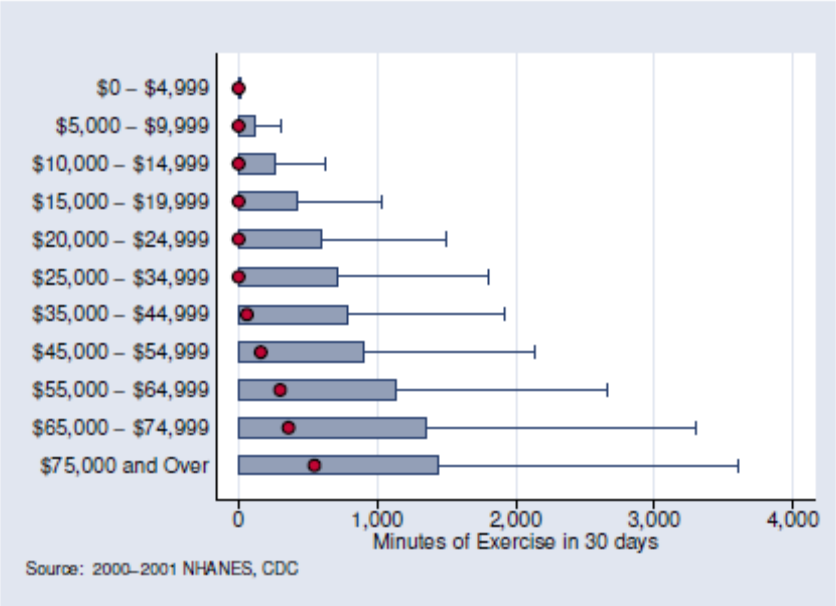
Models of exercise present many empirical difficulties. The opportunity cost and direct costs of exercising conflict with other aspects of the individual's life. Opportunity costs and ability to pay will be affected by a person's income level and by other personal characteristics. In this section it will be discussed how these difficulties translate to econometric problems and what tools will be used to try to correct them.

One of the imminent problems is that one does not observe caloric expenditure directly only how much exercise a person reports. This presents several problems. The first one is that people can misreport exercise. There is no clear reason why richer people might misrepresent themselves differently from poorer people and therefore it is assumed that this will not affect the consistency of my estimates[5]. Second, since we don't observe real caloric expenditure, our Y (minutes of exercise) is a latent variable. This paper will focus only on the leisure time activity to avoid this error in measurement. Any expansion of this topic into total caloric expenditure, the most relevant for obesity, must recognize the measurement error and correct appropriately.

[5] This is what is called a mean zero measurement error. Because the probability limit is zero then our estimates will be consistent. This can be easily shown using the FWL theorem and standard asymptotic theory.

There is also a problem of error in measurement in one of our explanatory variables. Income is not what affects your consumption of goods and exercise. It is wealth. The NHANES does not provide an individual's wealth just their income and therefore I will confine the study to that. It is reasonable to assume that this measurement error is larger when income is higher. Most poor people do not have property, stocks and other assets. For these people it is reasonable to think there is little measurement error. For high income earners there is more risk of measurement error but for my paper it is not as severe because the extremely wealthy people are lumped in one group. It is true that this might create a bias[6] in my coefficients.

Figure 4: Income vs. Exercise



Another problem, which is actually very common in health economics, is correlation between the explanatory variables. Socioeconomic characteristics like age, gender, race, education and income are prone to this problem because all of these theoretically affect each other. In this paper a simple correlation test and a variance inflation factor study show that the correlation is not as high as theoretically predicted and will allow for estimations that are reliable.

There is a particularity about our dependent variable. It has 47 percent of its observations equal to zero. This means that almost half of the sample does not exercise besides what might be done in their job and everyday life. It must be noted that all of the zeros do not necessarily reflect the same situation. Some people do zero exercise because they physically can't, others because they can't afford it, and others do no exercise because they don't want to. In this paper I want to discuss the latter two groups. It is important to control for people who cannot exercise but with the NHANES there is not much more to be studied about this group.

[6] If this was an OLS estimation the positive correlation between the measurement error and the income variable would be enough to show that the bias will be an attenuating effect on my coefficients.

It is important to consider some omitted variables. The distance to an exercise facility, the strenuousness of their jobs, and what was the reason for doing exercise are all factors that would be included if available. Another important variable that affects the amount of exercise a person does is weight. Because we do not have panel data there is no way to know if the person was overweight and used exercise to lower their weight, is doing exercise to lose weight, or has been in healthy weight all of their lives. Weight creates a causality and endogeneity problem. It is also the ultimate dependent variable in this area of study. It has decided that, because of the data set to be used, it is best to exclude BMI as an explanatory variable.

I will use two econometric tools to analyze the relationship between income and exercise. The use of multiple methods will provide two main things, validation of the results and more insight about how income affects exercise.

The first tool to be used will be TOBIT regression. This technique is used when you have a truncated dependent variable. In our case if we think of minutes of exercise as a propensity to do exercise we would only observe it when people actually do exercise if they don't we have no information. Using a design matrix X consisting of dummy variables for income group, gender, race, education, marital status and the continuous variable age our model would look like this:

$$Y^* = X\beta + \varepsilon$$
$$\begin{cases} Y^* & if\ Y > 0 \\ 0 & otherwise \end{cases}$$

This model has the advantage of giving insight into how averse people are to exercising. This will allow us to understand for example how many more people would exercise if they were provided a raise.

The second tool, the Heckman sample selection model, breaks the decision process in two equations. First weather or not the individual does any exercise. This is done using a Probit model in which Y_{select} is 0 if no exercise is done and 1 if any exercise is done at all. Second, a simple OLS estimation is done of the main equation Y_{main} that measures quantity of exercise using the residuals of the Probit model along with the Zs.

For this model our two design matrices are different. Education will not be present in the main equation but will be present in the selection equation. An individual's education will provide the motivation to do exercise for improving a weight problem but it will probably not affect how many minutes he spends in the gym. The selection equation will use the same X matrix defined before and the main equation will use a matrix the same as X but without the dummy for education and will be referred to as Z. Our model specification is as follows:

$$Y^*_{main} = Z\delta + \varepsilon$$
$$Y^*_{select} = X\beta + \varepsilon$$

Were the errors terms are assumed to be distributed as a joint standard normal, independent of X, Z and of expectation zero.

This model has many advantages because it controls better for the unobservable characteristics which we believe to be affecting both equations. It will allow me to distinguish the effect of income and other socioeconomic effects on first deciding if one will do exercise and in deciding how much of it to do.

5. Results

The results confirm the previous notion that an increase in income would yield an increase in exercise done. This section presents the results from each test separately. In the next section it will compare them, and suggest some questions for future studies.

In all of the models changing between the lowest four incomes groups (income of less than $25,000 a year) was not significant. Marital status was also not significant in our models. The “others" racial category did not appear to be significant either. This latter one might be expected because it was a small group with extremely different observations.

5.1. Tobit

Table 4: Additional Minutes of Exercise

Group	Minutes
$20,000 - $24,999	875
$25,000 - $34,999	1,000
$35,000 - $44,999	1,014
$45,000 - $54,999	1,040
$55,000 - $64,999	1,332
$65,000 - $74,999	1,542
$75,000 - over	1,512
Male	574
Attended College	646
White	632
Hispanic	558

Table 4 shows the effect of moving from the omitted group[7] to one of the others. The continuous explanatory variable, age, was significant and suggested that people do around 20 minutes less of exercise as they get a year older. A man does 574 minutes more than a woman. A Caucasian does 632 minutes more of exercise than an African-American. People who had some college education are expected to do 646 more minutes of exercise.

It is reasonable to think of changing several characteristics at the same time. For example, usually people with more education have higher salaries. A person who went to college and makes $70,000 a year does 2,088 minutes of exercise more than a person without a high school diploma and earning minimum wage.

[7]My omitted group is Black-Single-Women who never went to college.

5.2. Heckman Sample Selection

5.2.1. Selection Equation

The Heckman sample selection breaks up the model in two parts. The selection equation provides the probability of doing exercise and how each variable affects this probability. The main equation provides how the explanatory variables affect how much exercise a person does. This equation will be comparable with the Tobit regression.

The following table (Table 5) provides us with the changes in the probability of doing exercise given which group we are in. For our significant discrete variables (income, education, race, and gender) this probability change is the equivalent of moving from the comparison group (omitted group) to a group with the same characteristics except the one in question. For age the probability associated is the change in the probability of doing exercise given that you are a year older.

Table 5: Increase in the Probability of Doing Exercise

Group	Δ Probability
$20,000 - $24,999	18%
$25,000 - $34,999	19%
$35,000 - $44,999	21%
$45,000 - $54,999	25%
$55,000 - $64,999	27%
$65,000 - $74,999	31%
$75,000 - over	33%
Male	7%
White	13%
Age (1 year older)	-.06%

As expected the higher the income the more likely an individual is of doing exercise. Men are also more likely to do exercise than women and people who went to college are more likely as well. Again we find that Whites have a higher probability of doing exercise than Blacks.

Our omitted group has a 35 percent probability of doing exercise. A man that went to college and earns $100,000 a year would be 40 percent more likely to do exercise than our control group.

5.2.2 Main Equation

In the Heckman main equation we model the behavior of only the people who do exercise. This will cause our coefficients to be higher than the ones obtained from the Tobit but the sign and relationships should hold.

As can be seen in Table 6 our results are extremely similar. Higher income consistently increases the minutes of exercise that are done. Males do 560 more minutes than women, Whites 753 more than Blacks, and 100 more minutes than Hispanics. Getting a year older decreases exercise by 22 minutes. A White man who makes $100,000 a year does 3,127 more minutes of exercise than our control group.

In the final section the paper will compare and summarize the results of the two models and concludes by providing further questions and modifications that might be done in the future.

Table 6: Additional Minutes of Exercise

Group	Minutes
$20,000 - $24,999	957
$25,000 - $34,999	1,108
$35,000 - $44,999	1,164
$45,000 - $54,999	1,216
$55,000 - $64,999	1,555
$65,000 - $74,999	1,755
$75,000 - over	1,814
Male	560
White	753
Hispanic	653

6. Conclusions

Obesity is an epidemic that is taking the United States by storm. It affects minorities and poorer Americans the most. This paper used the NHANES to examine the role of income and other individual traits in the amount of exercise Americans do.

Using both Tobit regression and Heckman sample selection I find that for every income bracket above $25,000 a year, moving up in the income group consistently increases the minutes of exercise. Only in the Tobit model does the highest income group do less exercise than the next to highest. This is probably because there is a threshold of income which once you pass it you can easily afford the costs of exercise.

Men do about 500 more minutes of exercise than women. Whites do 600 or so more minutes of exercise than Blacks and 100 more than Hispanics. Individuals who went to college do on average 650 minutes more of exercise than those who didn't. People do about 20 minutes less of exercise for every year they get older. Marital status does not seem to be a major factor in the amount of exercise done.

Income was not only important in deciding the amount of exercise Americans do, it was also crucial in determining if a person decides to do exercise or not. People with higher income have a higher probability of exercising. Males, whites and people who went to college also are more probable of exercising.

It is evident that income is very important in the decision process of exercising, and controlling your weight. Americans' race, education, and age are also significant factors in their exercise behavior. Any serious discussion of caloric expenditure must consider these factors.

The ultimate goal of this paper and the study of Obesity is to find ways to improve the health of the millions of people who suffer from this problem around the world. To further examine this problem this study of exercise should be expanded to incorporate all forms of caloric expenditure. This means, first, to ascertain the impact of the different kinds of exercises people do. Second future studies must include other forms of caloric expenditure like work, transportation, and other everyday activities. To properly link these behaviors to Obesity more information about people's weight is needed. Panel-type data are a valid alternative and might provide information about the motivation of exercise and the causality of weight and exercise. Income should be substituted by some more comprehensive measure of wealth that might represent a person's ability to pay for exercise better. Information about health education would also be very helpful.

An important contribution of this paper is that it shows that income is significant in the exercising of Americans. Health policy targeting Obesity should consider making exercise facilities more accessible to people and neighborhoods who can't afford them. Obesity is a health problem but it highlights the need for social and economic equality in this country. We hope this is a stepping stone for economists and other researchers to continue to expand our knowledge of obesity and its socioeconomic causes and remedies.

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A Estimation Results

Significance levels: †: 10% *: 5% **: 1%

Table 7: Estimation results: Tobit

Variable	Coefficient	(Std. Err.)
Incdum2	264.665	(422.784)
Incdum3	524.404	(403.048)
Incdum4	467.320	(402.488)
Incdum5	875.029*	(401.138)
Incdum6	999.839*	(391.012)
Incdum7	1014.219*	(394.548)
Incdum8	1039.397**	(397.066)
Incdum9	1332.454**	(402.768)
Incdum10	1542.811**	(415.761)
Incdum11	1511.848**	(386.385)
Male	573.595**	(84.633)
Hispanic	557.972*	(218.618)
White	631.600**	(96.253)
Other	111.527	(246.006)
Age	-19.841**	(2.758)
Married	-117.250	(93.669)
More High School	646.230**	(92.441)
Intercept	-1069.925**	(403.609)
se	2340.603**	(38.448)

Table 8: Estimation results: Heckman S.S.

Variable	Coefficient	(Std. Err.)
Incdum2	258.487	(422.419)
Incdum3	563.144	(402.913)
Incdum4	527.033*	(402.382)
Incdum5	957.362**	(400.996)
Incdum6	1108.442**	(390.630)
Incdum7	1163.466**	(394.109)
Incdum8	1215.714**	(396.535)
Incdum9	1555.141**	(402.015)
Incdum10	1755.071**	(415.083)
Incdum11	1814.324**	(384.764)
Male	559.577**	(84.367)
Hispanic	653.348**	(217.595)
White	753.142**	(94.694)
Other	314.806	(243.5990
Age	-21.231**	(2.767)
Married	-124.304	(93.455)
Intercept	-891.330*	(403.067)

Equation 2: select		
Incdum2	0.103	(0.181)
Incdum3	0.225	(0.172)
Incdum4	0.206	(0.172)
Incdum5	0.406*	(0.171)
Incdum6	0.466**	(0.167)
Incdum7	0.489**	(0.168)
Incdum8	0.519**	(0.169)
Incdum9	0.658**	(0.172)
Incdum10	0.743**	(0.177)
Incdum11	0.777**	(0.164)
Male	0.242**	(0.036)
Hispanic	0.256**	(0.093)
White	0.319**	(0.040)
Other	0.123	(0.104)
Age	-0.009**	(0.001)
Married	-0.055	(0.040)
More High School	-0.001	(0.002)
Intercept	-0.377*	(0.172)
Equation 3: athrho		
Intercept	11.856	(7.092)
Equation4: Insigma		
Intercept	7.757**	(0.019)