Active Leisure, Passive Leisure and Health

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Abstract

Leisure consumption has been increasing in the United States since the 1960s. Over the same period, inactive lifestyles have contributed to adverse health outcomes. We propose a new way of categorizing leisure into groups based on the amount of physical exercise needed. Our results show that physically active leisure is a normal good whose demand rises with education and health, while physically passive leisure is an inferior good whose demand rises with lower education and poorer health. These patters allow us to propose a taxonomy that categorizes various leisure activities into 'Active' and 'Passive' groups.

Keywords: Time allocation, Active and Passive Leisure, Health;

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1. Introduction

Health plays a significant role in labor market outcomes. Following Grossman (1972), good health is presumed to improve productivity and participation in market work. A large body of literature [3] has generated a consensus that poor health has negative effects on wages and labor force participation, in line with Grossman's theory.

Research by Aguiar and Hurst (2007) shows that leisure consumption has increased dramatically in the United States since the 1960s whereas the number of market hours worked have remained relatively stable. During the same period, according to a study by Kuczmarksi et al (1994), incidence of obesity among US adults has seen a substantial increase. Such increasing trends in obesity, adult-onset diabetes and other ailments associated with inactive lifestyles have raised concerns about inadequate time allocated to exercise in the United States, leading to deterioration in health [Meltzer and Jena (2010)]. In the medical profession, it is well known that obesity not only impairs health and longevity, but ,"mortality due to lack of exercise and due to caloric intake is second only to tobacco consumption in the number of deaths that could be prevented by behavioral change." [Philipson (2001), McGinnis and Foege (1993).]

In the literature, some common reasons for increasing obesity which lead to deterioration of health, are cited as – lack of time for exercising, increasing reliance on cars and consumption of processed foods.[4] Although several indicators of health have seen an improvement since the 1960s,[5] sedentary lifestyles and associated adverse health consequences are so severe that the phenomenon has been referred to as "an obesity epidemic" by Philipson and Posner (2008). An argument advanced is that there is just not enough time for exercise [King *et al* (2000)].

In this context, we examine the following question: If lack of time is cited as a major reason for deteriorating health caused by obesity and other diseases related to lifestyle, how can it be that, over the same period, leisure consumption has actually gone up substantially? Shouldn't individuals who have spare time to watch TV and consume other sedentary forms of leisure also have time to exercise or engage in physically demanding nonmarket activities, which have positive effects on health?

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[3] Chirikos and Nestel (1985); Parsons 1977 ; Pelkowski and Berger (2004); and Cawley(2004)

[4] In the Australian context, a study by Banwell *et al* (2005) finds these to be major contributors. Although this study is for Australia, incidence of obesity and reasons associated are similar across the developed world.

[5] Such as declining morbidity and mortality in Case and Deaton (2015), coronary diseases in Ford (2007) and reduction in disability among the elderly in Cutler (2001)

One possible explanation is via income effects – worse health is associated with lower productivity which reduces wages, so individuals may or may not decide to work less depending on their labor-leisure preferences, leaving the overall effect on leisure ambiguous. Reverse causality is another challenge here –more available time may lead to better health due to engagement in exercise or conversely, better health may also provide more time to exercise because of income effects.

An interesting piece of this puzzle may be answered by looking at leisure activities in their active and passive forms. We show that in theory, active and passive leisure would respond differently to health endowments and income, which can explain the persistence of deteriorating health due to lack of physical exercise even as total leisure consumption rises.[6]

We address this question using the 2006-08 and 2014-16 waves of the American Time Use Survey (ATUS) that included information on self-reported health status. We show that there are differences in leisure types that correspond to presumed effects on health, and that individuals choose active and passive leisure differently depending on their current incomes, wages, and health status. Active Leisure that enhances or maintains health is a normal good whose demand rises with education and health. Passive Leisure that contributes to deteriorating health due to sedentary lifestyles, is an inferior good whose demand rises with lower education and poorer health. These results also suggest that Aguiar and Hurst's (2007) finding that the most educated are consuming less leisure is consistent with rising incomes for the most educated, which would raise the time they allocate to Active Leisure while lowering their use of Passive Leisure. Their finding that the least educated are consuming more Passive Leisure is consistent with the falling real incomes for the least educated which would raise their time spent on sedentary activities and contribute to rising rates of obesity and diabetes among the poor.

The empirical specifications focus on the relationship between health, income and leisure. Our empirical specification allows us to categorize leisure activities as either active or passive depending on their relationship to income, wages and health. Our results help to explain the puzzle of deteriorating health due to changes in lifestyle, even as consumption of leisure has been increasing in the United States. Our findings that Active and Passive Leisure respond differently to income and wages could help policymakers design mechanisms which encourage

[6] The relationship between health and leisure activities has been studied only by a handful of papers – Podor and Halliday (2012), Gimenez-Nadal and Ortega-Lapiedra (2013), Keuangkham (2017) and Ozturk and Kose (2019).

higher consumption of active leisure to reverse the rise of obesity and its related adverse health consequences.

The paper is arranged as follows – Section 2 reviews past studies that contribute to our analysis; Section 3 outlines the theoretical model; Section 4 describes the data; Section 5 proposes an econometric strategy; Section 6 discusses the results; and Section 7 concludes.

2. Literature Review

This paper fits into two branches of literature. First, economists have looked at the relationship between health and paid market work. These studies are complemented by a second group of studies which examine the relationship between health and unpaid work. Our paper contributes to the second group by examining the relationship between health, income and leisure time allocation.

Health and Paid Work

Grossman (1972) proposed that lost time is one of the major consequences of illness. His model forms the basis of several studies, which look at the effects of poor health on labor supply (e.g. Coile 2004, Wu 2003, Rust and Phelan 1997, Bound 1991).

Studies in this area have examined the relationship of poor health, caused by different factors, on various labor market outcomes. Bartel and Taubman (1979) studied the effects of specific diseases and found strong negative effects on earnings (20%-30% reductions) and negative effects on labor supply. Others have studied the negative impacts of diseases on labor market outcomes (Mitchell and Burkhauser 1990; Rees and Sabia 2015; Tunceli et al. 2005). Mental health and its relationship with labor market outcomes has also been studied extensively (Chatterji et al. 2007; Ettner, Frank, and Kessler 1997; Ojeda et al. 2010; Fletcher 2014). The main insight from these studies is that ill-health (physical or mental) is correlated with negative effects on employment, work hours and wages.

Health and Nonmarket Work

Health affects non-market work as much as it affects market work. There is substantial literature studying the gendered effects of health on housework (Gimenez-Nadal and Sevilla 2012, 2014; Ones, Memis, and Kizilirmak 2013; Robinson and Godbey 1999). Results are not always consistent. Podor and Halliday (2012) found that better health leads to more time

allocated to the market and to home production in the U.S., while Gimenez- Nadal and Ortega-Lapiedra (2013) found that in Spain, better health is associated with less time allocated to non-market work. While the link between exercise and obesity or BMI is difficult to measure precisely (Courtemanche et al, 2015, 2020), it is well understood that there exist positive effects of exercising on health. However, the tradeoffs between time investments in health and wages are complex. Higher opportunity costs of time lower time spent exercising (Chen et al, 2002; Lenhart, 2019)[7] and reduce average time spent sleeping (Biddle and Hamermesh, 1990). But while Pampel et al (2010) found that sleep deprivation lowers health and productivity, Ozturk and Kose (2019) find that less time spent on leisure and sleep is correlated with better health. Further complicating any analysis of health and leisure time allocation are findings that willingness to pay for health improvements themselves depend on current health, education and age (Johannesson, 1996; Johannesson and Johansson, 1997).

While the literature on labor supply is extensive (Keane, 2011; Keane and Rogerson, 2012), analysis of leisure by type is less developed. Aguiar and Hurst (2007) reviewed the trends in leisure demand over almost 40 years, starting in 1965. They found that less educated individuals were consuming more leisure while college educated individuals were consuming less leisure. Leisure demand responds to the business cycle (Aguiar et al, 2013), and to changing technology such as the development of virtual games (Aguiar et al, 2017).[8] There have been important changes in leisure over time and demographic groups, such as the large increase in television viewing for less-educated individuals while leisure demand for the most educated actually fell (Aguiar and Hurst, 2007). Recent work by Aguiar *et al* (2021) show that time spent on video gaming and recreational computing is a luxury good for younger men. Their study looks at six broad categories of activities, one of which is leisure.

3. Theoretical Model

Extending Becker's (1965) analysis of optimal time allocation, we develop a model of demand for Active and Passive Leisure. Individuals with different health endowments will consume

[7] The findings in these studies may not hold more generally. The wage measure in Chen et al (2002) is a generated value based on a regression and not an observed value, and the estimated wage effect in Lenhart (2019) is the effect of state minimum wages on exercise time for a sample of low skill workers.

[8] Young men are devoting more time to video gaming and recreational computer use to the extent that they are lowering time spent working.

different amounts and types of leisure. Our model will identify how allocation of time towards different types of leisure activities is affected by health endowments, holding constant other factors such as education, age, gender, location and race. The theoretical model generates reduced form time allocation equations and testable hypotheses that will guide our empirical work.

The utility maximization problem for the individual consists of three primary choices: active leisure (A); passive leisure (P); and an aggregate market good (x). The individual derives pleasure from all three.

(1) $U = U(x, A, P)$

The objective function is to maximize utility, subject to constraints on income and time. The budget constraint specifies money income which is obtained by working T hours at the remuneration rate $w(H, Z_L, Z_D)$. The hourly wage is assumed to depend positively on current health (H), an assumption which is based on results of several studies which show positive association between the two[9]. Z_L denotes a vector of local labor institutions that also affect wages but not the marginal utility of leisure such as union coverage, occupation and industry. Z_D is a vector of demographics such as age, education, and gender that may affect both the wage and the demand for leisure. Y denotes non-wage income. We normalize the price of market goods to be 1. The budget constraint is

(2) $w(H, Z_L, Z_D).\boldsymbol{T} + Y = x$

The time constraint standardizes total time available to be 1, and so time spent at work, and on Active and Passive leisure represent proportions of time that add up to 1:

(3) $T + P + A = 1$

Next, we make a key assumption that utility (enjoyment) from Active leisure also depends on the level of health.

The motivation behind this assumption is straightforward: Unhealthy individuals cannot derive the same satisfaction from the time spent on physical activity as can someone who is healthy. On the other hand, consumption of Passive leisure is not limited by health at all since it does not require any physical exercise and hence it enters the utility function on its own. This prompts us to specify the utility function as

[9] Ettner (1996) shows that higher income is associated with better mental and physical health. Frijters *et al (2005)* find significant positive association between health and income.

(1A) $U(x, A, P) = U(w(H).(1 - A - P), f(H) \cdot A, P)$

where $f(H)$ denotes how efficiently health is converted into satisfaction derived from Active leisure. Presuming diminishing marginal utility, we assume that $f'(H) > 0, f''(H) < 0$. For simplicity, Equation 1A uses a wage equation where wages depend only on health.

Assuming utility function to be separable in goods and leisure:

$U(x, A, P) = u(x) + v(f(H).A, P)$

FOCs imply that:

$v_A(f(H)A^*, P^*).f(H) = v_P(f(H)A^*, P^*)$

Which yields the marginal rate of substitution between active and passive leisure,

$$f(H) = \frac{v_P(f(H)A^*, P^*)}{v_A(f(H)A^*, P^*)}$$

The greater the utility derived from active leisure, the greater has to be the marginal utility from passive relative to active leisure. Along any indifference curve, healthier people will pick more active leisure intensive time allocations.

While the compensated effect implies that increases in health endowments will raise the share of time spent on Active leisure, the uncompensated effect is ambiguous. However, we can show that the reduced form effects for Active and Passive leisure will not be the same.[10] In particular, the reduced form effects of the health endowment and income on the two types of leisure will be different. To explore those issues, we need empirical analysis of the effects of health on demand for leisure by type, motivated by the reduced form equations:

(4A) $A = A(H, w(H, Z_L, Z_D), Z_D, Y)$

(4B) P= $P(H, w(H, Z_L, Z_D), Z_D, Y)$

Equations 4A and 4B form the basis of our empirical specifications where we examine how demand for A and P are associated with H, $w(H, Z_L, Z_D)$, Z_D, and Y. We make a distinction between wages $w(H, Z_L, Z_D)$ and income Y, where we use family income as a measure of nonlabor income Y, which is not directly associated with the individual's health. Models with both are estimated below.

One limitation of the theoretical model is that it does not take into account the potential dynamic relationship between stock of health (H) and Active leisure (A). While we assume that

[10] Please see Appendix for details

utility derived from Active leisure is dependent on the health level of the individual, it is also likely that physical exercise due to higher participation in Active leisure also affects health.

4. Data

We use data from the 2006 - 08 and 2014-16 waves of the American Time Use Survey (ATUS). These surveys elicit responses on the time individuals spend on various activities including time spent at market work, household work such as childcare, cooking or cleaning, nonmarket work such as volunteering, and leisure activities such as recreation or watching television. The ATUS sample is drawn from the Current Population Survey (CPS) and includes residents aged 15 or older living in the United States. The sample excludes active military personnel and individuals living in institutions (e.g. hospitals and prisons). Various waves of the ATUS include unique modules. Since we are interested in exploring the association of health and time allocation choices, we use the ATUS Eating and Health (EH) module which was carried out from 2006 to 2008 and 2014 to 2016. Health is reported in five categories – excellent, very good, good, fair and poor.

This study also requires information on how individuals allocate 24 hours in a day in various activities. The best source of data for this purpose are the ATUS Activity Summary Files. These files contain information about the total number of minutes each respondent spent doing each activity. The level of detail in this dataset is such that every minute out of a total of 1440 minutes in a day are accounted for. The broad categories in the ATUS activity summary files include - personal care, household activities, caring for household members (childcare, adult care), caring for non-household members, work-related activities, education, leisure (includes socializing and relaxing) and sports. This provides us with detailed information on how individuals choose to allocate their time in a typical day.

For this study we merge the ATUS EH module data with the ATUS activity summary files using the unique household identifier. Since only one member was interviewed from each household, this makes sure that the individuals in the EH module and the Activity Summary files can be uniquely identified. Different households are surveyed every year. This sample consists of data on 64,798 individuals.[11]

[11] Distribution over years: 11,153 from 2006; 10,660 from 2007; 10,937 from 2008; 11,212 from 2014; 10,626 from 2015 and 10,210 from 2016 for a total of 64,798 individuals

For the American Time Use Surveys, individuals are randomly selected from a subset of households that have completed their eighth and final month of interviews for the Current Population Survey (CPS). ATUS respondents are interviewed only once about how they spent their time on the previous day, where they were, and whom they were with. The survey is sponsored by the Bureau of Labor Statistics and is conducted by the U.S. Census Bureau. Next we list the key variables used in the study. More details are in the appendix.

4A. Health Status (H)

The Eating and Health module respondent files for the American Time Use Survey (2006-08) contains the variable *EUGENHTH* which is the response to the question – 'In general, would you say your physical health was excellent, very good, good, fair or poor?'. The response of this question is one of the 5 categories (excellent, very good, good, fair or poor). We use this categorical variable to create a dummy for each health category. Our excluded category is the middle category (good). Summary statistics for this variable are reported in table 1. Among the 64,798 individuals in our dataset responses were as follows: 19% Excellent, 34% Very Good, 31% Good, 12% Fair and 4% Poor. Overall, out of 32,750 individuals, Excellent and Very Good health account for 33,831 individuals whereas Fair and Poor health are reported for 10,526. The first group can be considered to be respondents in good health and the second to be ones who are not in good health for this analysis.

4B. Nonlabor Income (Y)

We use a measure of family income *HUFAMINC* from the American Time Use Survey- Current Population Survey (ATUS-CPS) files. This variable measures the combined family income of all members of the household in the last one year. It includes money from jobs, net income from business, farm or rent, pensions, dividends and interest income. It also includes social security income. The variable reported in the ATUS-CPS files is not continuous – it is reported in bins of varying sizes from $0 to $150,000. We convert these bins to create a continuous variable by taking the midpoints of the bins. Since the top bin measures income greater than $150,000 we use a 'highest income' dummy variable for this bin. We convert the continuous income variable in thousands for easier interpretation of coefficients.

4C. Leisure Activities

The Activity Summary files in the ATUS use the ATUS activity coding lexicon which is a 3 tier classification system. There are 17 first-tier categories that we will be aggregating into Active

(*A*) and Passive (*P*) leisure. The number of minutes an individual spends during the diary day in such activities add up to 1440. Due to the level of detail in the data, the dataset contains a lot of zeroes. The following are the time allocation choices that we categorized as leisure. They sum up to 324 minutes on average, or 22.5% of the average day. The average amount of time spent on each leisure type is shown in Figure 1.

Sports*:* Playing baseball, playing basketball, playing billiards, participation in equestrian sports, fencing, fishing, playing football, golfing, doing gymnastics, playing hockey, participation in martial arts, playing racquet sports, playing rugby, playing soccer, softball, vehicle touring/racing, playing volleyball, walking, participation in water sports, weightlifting/strength training, working out (unspecified), wrestling, and ping pong.

***Non-Sports*:** Doing aerobics, biking, boating, bowling, climbing (includes spelunking and caving), dancing, hiking, hunting, participation in rodeo competitions, rollerblading, running, skiing (includes ice skating and snowboarding), using cardiovascular equipment, doing yoga, bungee jumping.

Socializing: Socializing and communicating with others, attending or hosting social parties/receptions/ceremonies and attending meeting for personal interest.

***Television Viewing*:** Watching television and movies (not religious), television (religious), listening to the radio and listening to/playing music (not radio)

Relaxing: Doing nothing/goofing off/wasting time, hanging around/hanging out (alone), sitting in the hot tub/Jacuzzi/whirlpool/sauna, breaks at work, unspecified activity, watching wife garden/watching husband cook dinner, lying around/ sitting around, sunbathing, grieving, worrying/crying, watching husband assemble lawnmower, resting/relaxing/lounging, reflecting/daydreaming/fantasizing/wondering, looking at pictures in a photo album or looking at photos on computer or camera.

Arts: Performing arts

***Tobacco Consumption*:** Smoking a cigarette/cigar/pipe, smoking marijuana/pot/weed, having a cigarette/rolling a cigarette or chewing tobacco/using recreational drugs.

Games (Indoor): Playing board games/ Scrabble/cards, hitting a piñata, playing games over the Internet, spinning dreidels, hiding matzo/ hiding Easter eggs or working jigsaw puzzle/crossword puzzles.

Computer Use: Unspecified computer use, surfing the internet, downloading files/music/ pictures (personal interest), burning CDs, using social networking or computer programming (personal interest)

Hobbies: Scrapbooking/making a scrapbook, making Halloween costumes (for self), making holiday/ other decorations, dyeing Easter eggs, artistic painting, videotaping/ photography/model making/ jewellery making, making pottery/sculpting/wood working, making Christmas decorations, taking pictures, collecting/organizing stamps or coins, bird watching, researching family tree, reading for personal interest, writing for personal interest.

4D. Demographics (Z_D)

The elements of the vector of personal attributes Z_D that may affect both wages and demand for leisure include:

***Years of formal education*:** The ATUS Activity Summary files includes a measure of accumulated schooling.

Female: Dummy indicating the respondent is female.

Age: Age of respondent (*TEAGE* in ATUS dataset)

Number of children: Number of children in the household less than 18 years of age (*TRCHILDNUM* in the Activity Summary files)

White: Dummy variable indicating respondent is White

Black: Dummy variable for Race of respondent being Black (=1 if respondent is black, 0 otherwise) (using the *PTDTRACE* variable in ATUS)

Other Race: Dummy variable indicating Race other than White or Black.

Metro: Dummy variable indicating respondent lives in a Metropolitan area

Table 1 provides summary statistics for all variables used in this study. As is clear from table 1, The top three categories on which Americans spent the most amount of time, between 2006-8 and 2014-16 are TV viewing, socializing and hobbies. The bottom three are Tobacco, Arts and Sports.

5. Methods

a. Econometric Model

Our econometric model uses the number of minutes spent on a particular activity as the dependent variable. For each individual *i* in year *t*, total leisure time (L_{it}) is decomposed into active (A_{it}) and passive (P_{it}) types according to:

$L_{it} = P_{it} + A_{it}$

Denote each leisure type *j* by L_{it}^{j}. We will allocate L_{it}^{j} to either (A_{it}) or (P_{it}) . Applying (4A) and (4B), health may affect leisure allocation in two ways, indirectly through the wage which affects the value of time and directly through its effect on the relative utility of Active versus Passive leisure. The form of the econometric model is OLS regression of the following form:

$$(5) \qquad L_{it}^{j} = \alpha_j + H_{it}'\beta^j + Z_{D}{}_{it}'\gamma^j + Y_{it}\theta^j + S_i\rho^j + \varepsilon_{it}^{j}$$

where H_{it}' is a vector of health status brought into the period, $Z_{D}{}_{it}'$ is a vector of demographic measures, S_i is a vector of state fixed-effects and Y_{it} is household income. In this formulation, we implicitly assume that the wage is determined entirely by demographic and health factors and so its effect is captured by the other regressors, an assumption we will relax later. The vector of health coefficients, β^j, will represent the correlation between health status and leisure choice through the combined effects of the wage and Active leisure productivity channels.

Because time allocation and health are subject to choice over the lifespan, even if current health is not easily adjusted, both are likely subject to unobserved variables which raises concerns about endogeneity in the health measures in equation (5). Two strategies have been advanced in the literature. Gimenez-Nadal and Ortega-Lapiedra (2013) suggested an instrumental variable technique where regional average health measures are used to instrument for individual health. Following that strategy, we estimated equation (5) where health was instrumented by state averages of obesity, binge drinking, smoking, and diabetes. While the instruments passed standard tests for weak instruments and exogeneity, the results generated some health effects on time allocations that seemed implausibly large.

For that reason, we applied the strategy suggested by Ozturk and Kose (2019) that embeds the estimation of equation (5) in a system equation to correct for correlations in the error terms across equations. We use Seemingly Unrelated Regression (SUR) models to estimate equation (5) for all leisure time allocation choices. More importantly, the strategy employs a large number of fixed effects for states, time periods, and demographics (household size, race) to

capture the effect of common unobservables on health. These coefficients are interpretable as the correlation between individual time allocation and the deviations of individual health status from the norms for the individual's state, year, age, race, and household size. These norms would include the type of fixed state averages of health outcomes used as instruments in the Gimenez-Nadal and Ortega-Lapiedra (2013) strategy. Our results generated the same signs as the IV strategy but yielded more plausible results.

Our interest is in finding regularities in how time allocations respond to these deviations health and to income. The pattern of coefficients supports the establishment of a taxonomy that aggregates various leisure types into Active or Passive groups based on their correlations with health and income.

b. **Aggregation**

The leisure types are too numerous for a parsimonious representation of leisure demand which motivates us to develop aggregations of leisure types. We use the reduced form equation (5) to test if pairs of variables are sufficiently similar in their relationship with health status and income that we can impose joint equality of all 5 parameters relating leisure demand to health status and income.

Specifically, we test whether the coefficients on predetermined health are jointly equal: $\beta^j = \beta^{j'}$ and $\theta^j = \theta^{j'}$ for leisure types $j \neq j'$.

With 5 equality restrictions, each hypothesis is distributed $\chi^2(5)$. If the null hypothesis cannot be rejected, then we conclude that the relationship between the two leisure types are aggregable. Rejection of the null suggests the two leisure types are not aggregable.

c. Wage Estimation

It is useful to know how much of the education and age effects operate through the taste mechanism and how much works through the opportunity cost of time. To investigate that question, we need to estimate a wage equation, $w(H, Z_L, Z_D)$, that includes factors Z_L that would shift wages without affecting the tastes for leisure. That exercise is admittedly hard to validate, but we suggest two possible identification schemes. One is union membership or coverage that is known to raise wages but would not have an obvious effect on leisure tastes. A second is a

form of the Bartik (1991) instruments where we examine deviations from past expected wages by occupation and industry. The individual hourly wage is the dependent variable.

$$w_{it} = \alpha_j + \mu.Union_{it} * year + \varphi.Industry_{it} * year + \omega.Occupation_{it} * year + Z'_{it}\gamma^j + \varepsilon^j_{it} \quad (6)$$

where Z'_{it} represents a vector of demographics including age, education gender but not health, as we want to estimate the wage independent of the individual's health status, to capture the expected value of time based on skill and market factors

In the second stage, we estimate the AL and PL equations with the predicted wage from equation (6) as a regressor. Because the predicted wage is a generated regressor, we use bootstrapped standard errors based on 50 replications to correct for the sampling variation in the first-stage estimation.

$$L_{it} = \alpha_j + \partial.\widehat{w\_it} + H'_{it}\beta + Z'_{it}\gamma + Y_{it}\theta + S_i\rho + \epsilon_{it} \quad (7)$$

Where L_{it} represents AL_{it} or PL_{it}, the aggregate Active and passive leisure groups and $\widehat{w\_it}$ represents the predicted wage from equation 6.

6. Results

The econometric model laid out in section 5 is used to estimate the relationship of health and various leisure time allocation choices. We use the pattern of responses to justify which activities to allocate to Active leisure and which fit under the Passive leisure category.

6A. Health, Income and Leisure Time Allocation

Table 2 contains results of the econometric estimation on each leisure activity – Sports, Non-Sports, Television Viewing, Socializing, Arts, Tobacco Use, Relaxation, Games, Computer Use and Hobbies. The dependent variable for all regressions reported in this table is the minutes spent on the jth leisure activity. Examining Table 2 reveals a pattern on how health is associated with leisure time allocation choices. The joint test of the null hypothesis that the four health categories do not affect time spent on each of the various leisure activities is rejected in every instance. However, the pattern of results are very different.

The two types of leisure that undoubtedly require physical exercise are - Sports and Non-Sports. The distinction between the two seems arbitrary at times with walking being under Sports and Hiking being under Non-Sports. For these two categories, excellent and very good health are significantly positively correlated with more time spent. The other leisure category which has a similar relationship with health is Arts – perhaps because it is intellectually if not

physically active. We tentatively combine Arts with Sports and Non-Sports in the Active Leisure group.

The opposite pattern holds for Television Viewing, Socializing, Tobacco Use, Relaxation, Computer Use and Games for whom very good or good health is negatively associated with time allocation. The most consumed leisure category (Figure 1) is Television Viewing that is consumed at an average of 3 hours per day. Individuals with poor health allocate 73 more minutes to television viewing than do individuals in the reference group with good health. Television Viewing increases as health deteriorates, consistent with Podor and Halliday's results (2012) who calculate that movement from good to bad health results in 335 additional hours of TV viewing for men, and 304 additional hours for women. A similar, though less dramatic, pattern holds for Relaxation and Socializing.

We compute health elasticities for all leisure activities and report them in table 3. The elasticities again show a pattern. Active Leisure types (Sports, Non-Sports and Arts) have positive values for good and excellent health and positive income elasticities. The more sedentary Passive Leisure types (Television Viewing, Tobacco, Relaxation, Games, Socializing, Computer Use and Hobbies) have negative or very small elasticities with respect to excellent health, good health, and income.

Because income is associated positively with the Active Leisure types, Sports, Non-Sports, and Arts are normal goods in the necessity range. Some of the sedentary leisure activities including Television Viewing, Socializing, Tobacco Usage, Relaxation, and Games are inferior goods. Hobbies and Computer Use are virtually insensitive to income.

The patterns of leisure choice in response to health endowments and income suggest a strategy for aggregating the leisure types into aggregates which we will call Active Leisure and Passive Leisure. Logically, if two leisure types are part of the same group, they should share a common reduced form relationship to the exogenous variables in equations (4A, B).

6B. Aggregation

The results of tables 2 and 3 suggest a plausible aggregation. Some of the relationships are illustrated in Figure 2. Time spent on Sports and Non-Sports fall as health status deteriorates from excellent to fair and then levels off, consistent with the coefficient patterns in table 2. Television Viewing and Socializing increase as health deteriorates.

Visual inspection of the coefficients on the health and income measures in Table 2 show three leisure types with positive income effects, Sports, Non-sports and Arts. All three have a

pattern that better than average self-reported health increases time allocation while poorer than average health measures lower time allocation. We combine Sports, Non-Sports, and Arts into an aggregate category, Active Leisure. In Table 4, we report pairwise tests involving our aggregate Active Leisure group and all the other leisure types. We reject the null hypothesis that Active Leisure and each leisure type has the same coefficients on health and income. The null is rejected for every test, a result which would occur randomly 0.4% of the time. We use that finding along with the qualitative similarity in their relationships to health status and income to justify combining all the remaining leisure types into our Passive Leisure aggregate.

After aggregation, we estimate the leisure groups (Active and Passive) with the same specification as in (5). Results are reported in table 5. Columns (1) and (3) report the unrestricted reduced form specifications. These estimations can be viewed as the generalization of the leisure type regressions reported in table 2. Endowments of excellent and very good health are positively and significantly associated with more time spent on Active Leisure, but are negatively associated with participation in Passive Leisure. The implied elasticities reported in Table 6 tell us that the responses of Active and Passive Leisure to health status are very small. The income elasticities show that Active Leisure is a normal good in the range of necessities, while Passive Leisure is an inferior good.

6C. Health and Wages

The analysis in columns 1 and 3 in Table 5 subsume the wage effect into the effects of education and work experience on leisure demand. We estimate equation (6) and use the predicted wage in equation (7). The results of the first stage wage estimation are in the Appendix table A2. Results of the second stage estimations of equation (7) are reported in columns (2) and (4) of table 5.

The previous results for health are virtually unaffected. The coefficients on predicted wage are significant for Active Leisure and Passive Leisure. While the sign is positive for Active Leisure, it is negative for Passive Leisure. We interpret this as the opportunity cost of changing with higher expected wages. Higher wages cause a substitution from passive to active forms of leisure.

The income measure we have used in this study is family income. However, the wage estmation along interpreted in conjunction with family income point to the fact that as purchasing power increases, individuals prefer to consume more active leisure and less passive

leisure. This points towards robustness of our initial results and proves that aggregation of various leisure activities in this way is meaningful.

In the first column in Table 4, the partial effect of education evaluated at the sample mean for age is negative on Active Leisure through 16 years of schooling.[12] However, after controlling for the predicted wage, the marginal effect of education is positive on Active Leisure at all schooling levels . The negative net effect in column 1 is due to the positive effect of education on the opportunity cost of time, which lowers demand for Active Leisure, even as education itself strengthens taste for Active Leisure. In column 3, the partial effect of education on Passive Leisure is initially positive but turns negative after grade 2. The negative effect increases in magnitude as education increases. After controlling for predicted wage, the marginal effect is negative at higher levels of education. This suggests that additional years of schooling results in declining taste for Passive Leisure.

Americans have been consuming more leisure over the last 50 years. But as shown by Aguiar and Hurst (2007), the consumption of leisure has risen the most for the least skilled. Sedentary leisure activities have been shown to contribute to rising rates of obesity, diabetes, and other health related illnesses. This analysis shows that there is a strong education component to the Aguiar and Hurst (2007) findings. The most educated have been experiencing rising wages, rising taste for Active Leisure, and rising incomes which further increase their demand for Active Leisure. Meanwhile, these same factors are lowering their demand for Passive Leisure. The least educated have the strongest taste for Passive Leisure and the weakest taste for Active Leisure. They have been experiencing falling real incomes which raise their taste for Passive Leisure, an inferior good, and falling taste for Active Leisure. Hence, there is a widening gap in healthy lifestyles between the more and less educated. Obesity, diabetes and other adverse health consequences of sedentary life styles are concentrated among the least educated and lowest income earning segments of the population.

These findings illustrate the importance of the $f(H)$ term in the theoretical model. Although the opportunity cost of time is the same for Active and Passive leisure, an individual is not indifferent between choosing Active versus Passive leisure as their health improves. As

[12] The estimated education effect is of the form $\frac{\partial L_{it}^{j}}{\partial E_{it}} = \gamma_E + 2 \cdot \gamma_{EE} \cdot E_{it} + \gamma_{EA} \cdot A_{it}$, where E_{it} is years of schooling and A_{it} is age. We evaluate the partial derivative at the sample average age of 47 years and alternative levels of education

predicted in equation (5) and verified in table 5, better health raises the utility of Active relative to Passive leisure. We know that wages rise with improved health also, but without that rising utility from Active leisure as the health endowment rises, you would not get the separation in leisure choices between healthier and high wage versus less healthy and low wage individuals.

7 Conclusion

In light of the insights made by Aguiar and Hurst (2007) of an increasing trend in leisure consumption in the U.S., this analysis provides a deeper understanding of the interrelationships between education, health and leisure demand. . We show both theoretically and empirically how health endowments and education will alter the choices of leisure activities that will and will not enhance health. The model suggests that the reduced form relationships between health and income and leisure demand would allow us to aggregate leisure into two types, Active and Passive. These two types of leisure have sharply contrasting reduced form relationships with health endowments and income. Higher income, more education and better health endowments are positively associated with the demand for Active Leisure, while lower income, less education and inferior health are negatively associated with demand for Passive Leisure. In crafting policies aimed at halting the trend toward rising obesity and diabetes, these results suggest that breaking the cycle of poverty by raising years of schooling but also by emphasizing physical education for young children would leave them with better endowments of health and education when they enter the labor market. Because health and education both reinforce ability to generate incomes which may raise the demand for Active relative to Passive Leisure, this strategy has the potential to generate reinforcing behaviors that would enhance health and income over the life cycle. This latter strategy would require longitudinal data to confirm this implication of our cross-sectional analysis.

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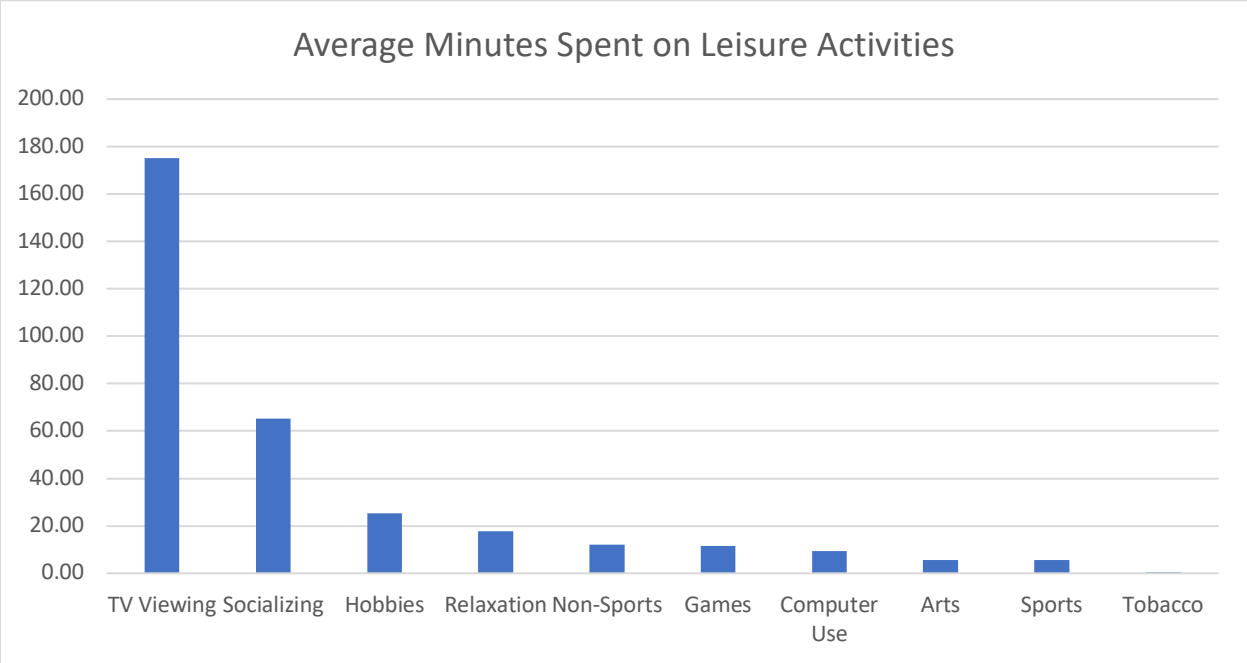
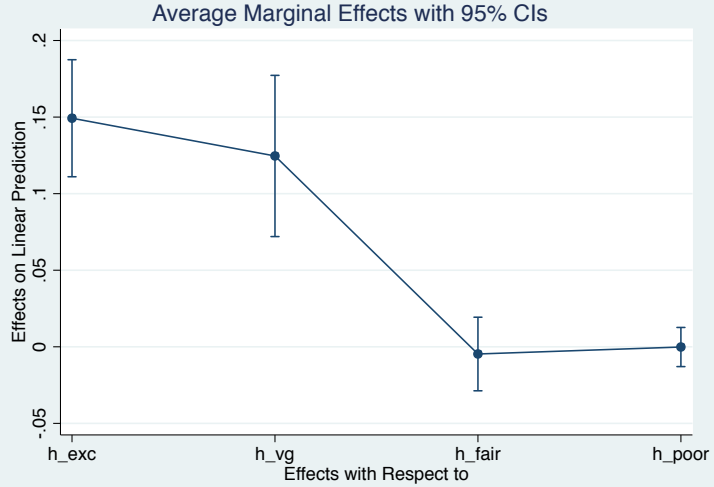
Figure 1: *Average number of minutes spent on leisure activities*



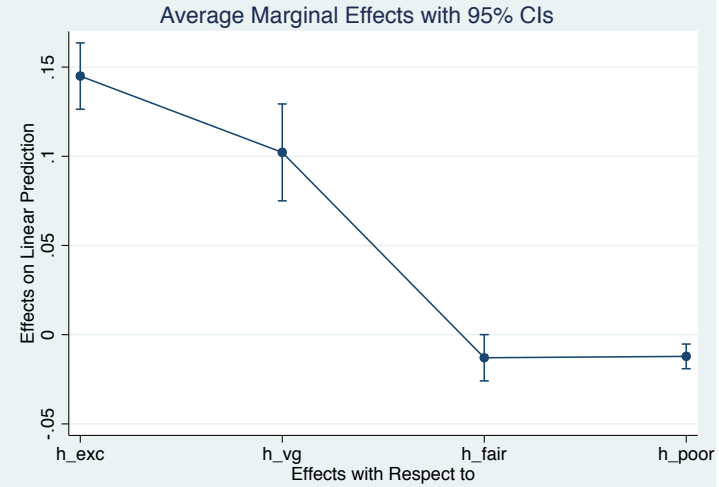
Data Source: American Time Use Survey (ATUS) – Eating and health Module from 2006 to 2008 and 2014 to 2016 (Sample size: 64,798)

Figure 2: Elasticities of health

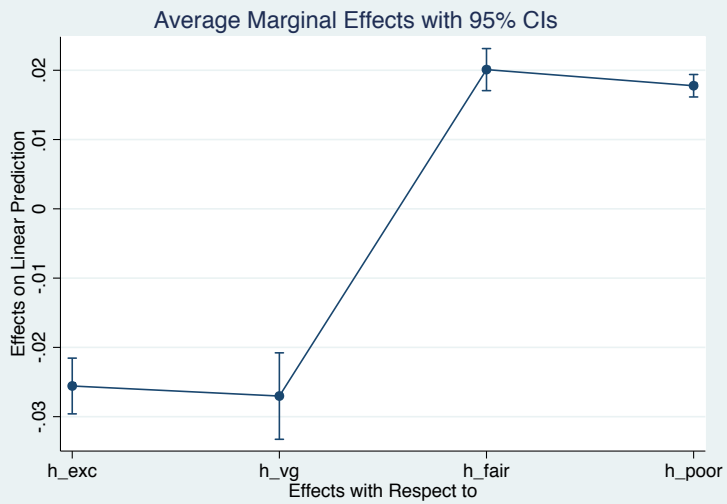
Sports



Non Sports



Television Viewing



Socializing

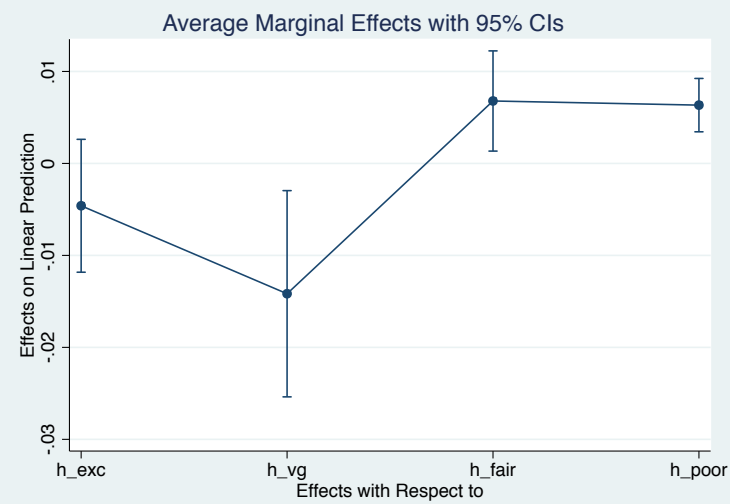


Table 1: Summary Statistics of key variables

Variable	*N*	*Mean*	*Std. Dev.*	*Min*	*Max*
Sports	64,798	5.5	33.4	0	1230
Non-Sports	64,798	12.0	43.5	0	1073
TV Viewing	64,798	175.2	175.6	0	1433
Arts	64,798	5.7	35.8	0	870
Tobacco	64,798	0.4	4.9	0	475
Relaxation	64,798	17.7	62.6	0	1095
Games	64,798	11.6	50.9	0	1156
Computer Use	64,798	9.5	41.1	0	990
Socializing	64,798	65.2	111.2	0	1151
Hobbies	64,798	25.4	66.9	0	1370
Excellent Health	64,798	0.2	0.4	0	1
Very Good Health	64,798	0.3	0.5	0	1
Fair Health	64,798	0.1	0.3	0	1
Poor Health	64,798	0.0	0.2	0	1
Income (thousands)	64,798	61.2	43.6	2.5	150
Age (years)	64,798	47.2	17.8	15	85
Education (years)	64,798	13.9	3.1	0	23
Gender	64,798	1.1	0.7	0	2
Race_White	64,798	0.8	0.4	0	1
Race Black	64,798	0.1	0.3	0	1
Number of Children	64,798	0.9	1.1	0	11

Data Source: American Time Use Survey (ATUS) – Eating and health Module from 2006 to 2008 and 2014 to 2016. Income variable if from CPS. Leisure activities (Sports, Non-Sports, TV Viewing, Socializing , Arts, Tobacco, Relaxation, Games, Computer Use and Hobbies) are in minutes. Health, gender and race variables are dummies .

Table 2: SUR Time Allocation estimates:

Dependent Variable: **Minutes spent on leisure activity**	**Sports**	**Non-Sports**	**Television viewing**	**Socializing**	**Arts**	**Tobacco Use**	**Relaxation**	**Games**	**Computer Use**	**Hobbies**
Excellent Health	3.575***	8.430***	-23.91***	-1.632	1.137**	-0.216***	-2.418***	-3.053***	-1.056*	1.892*
	(9.18)	*(16.53)*	*(-12.47)*	*(-1.25)*	*(2.69)*	*(-3.72)*	*(-3.34)*	*(-5.14)*	*(-2.18)*	*(2.52)*
Very Good Health	1.611***	3.207***	-13.64***	-2.711*	1.323***	-0.130**	-2.727***	-1.498**	0.289	1.239*
	(4.94)	*(7.51)*	*(-8.49)*	*(-2.48)*	*(3.74)*	*(-2.68)*	*(-4.50)*	*(-3.01)*	*(0.71)*	*(1.97)*
Fair Health	-0.170	-1.136	28.40***	3.637*	-0.867	0.0717	2.236**	1.630*	1.211*	0.401
	(-0.38)	*(-1.96)*	*(13.00)*	*(2.44)*	*(-1.80)*	*(1.09)*	*(2.71)*	*(2.41)*	*(2.20)*	*(0.47)*
Poor Health	-0.0151	-3.130***	73.54***	9.946***	-0.615	0.204*	13.13***	1.561	2.818**	-0.231
	(-0.02)	*(-3.46)*	*(21.59)*	*(4.29)*	*(-0.82)*	*(1.98)*	*(10.22)*	*(1.48)*	*(3.28)*	*(-0.17)*
Income	0.0338***	0.0272***	-0.382***	-0.0397**	0.0189***	-0.00391***	-0.0503***	-0.00980	-0.00321	-0.0129
	(7.98)	*(4.91)*	*(-18.31)*	*(-2.79)*	*(4.11)*	*(-6.19)*	*(-6.39)*	*(-1.52)*	*(-0.61)*	*(-1.57)*
Age	-1.207***	-0.201***	-0.0828	-0.168	-0.300***	0.0291***	0.593***	-2.356***	-0.845***	-2.437***
	(-26.66)	*(-3.38)*	*(-0.37)*	*(-1.11)*	*(-6.10)*	*(4.32)*	*(7.04)*	*(-34.09)*	*(-15.03)*	*(-27.87)*
Age^2	0.00670***	0.00155**	0.0269***	0.0151***	0.00190***	-0.000361***	0.00755***	0.0181***	0.00321***	0.0232***
	(16.36)	*(2.90)*	*(13.35)*	*(10.96)*	*(4.27)*	*(-5.92)*	*(9.91)*	*(28.89)*	*(6.31)*	*(29.37)*
Education	-2.141***	-1.272***	6.236***	0.586	-0.0837	0.102**	-0.108	-0.423	-0.589*	-1.687***
	(-9.33)	*(-4.23)*	*(5.51)*	*(0.76)*	*(-0.34)*	*(3.00)*	*(-0.25)*	*(-1.21)*	*(-2.06)*	*(-3.81)*
Education^2	0.0111	0.0538***	-0.332***	0.0724**	0.00979	-0.00459***	0.0794***	-0.0515***	-0.0146	0.00767
	(1.55)	*(5.76)*	*(-9.46)*	*(3.03)*	*(1.27)*	*(-4.33)*	*(5.99)*	*(-4.74)*	*(-1.64)*	*(0.56)*
Gender	-4.590***	-5.917***	-41.43***	1.524	0.0876	-0.105**	-3.667***	-4.652***	-2.429***	5.558***
	(-17.45)	*(-17.17)*	*(-31.97)*	*(1.73)*	*(0.31)*	*(-2.69)*	*(-7.50)*	*(-11.59)*	*(-7.43)*	*(10.95)*
Age * Education	0.0324***	-0.000358	-0.0601***	-0.0894***	0.00258	-0.0000437	-0.0729***	0.0317***	0.0315***	0.0808***
	(13.92)	*(-0.12)*	*(-5.24)*	*(-11.45)*	*(1.02)*	*(-0.13)*	*(-16.84)*	*(8.92)*	*(10.88)*	*(17.98)*
Joint Effect of Health (F statistic)	65.06***	144.07***	892.18***	55.14***	34.13***	14.07***	220.15***	12.18***	2.23***	5.24***
Year Fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Race Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Metropolitan Area dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Highest Income Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Chidren	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Number of Observations	*64798*	*64798*	*64798*	*64798*	*64798*	*64798*	*64798*	*64798*	*64798*	*64798*
R Squared	0.02	0.019	0.14	0.015	0.006	0.004	0.04	0.02	0.01	0.1
F	27.67	17.93	162.27	14.74	6.11	3.86	44.59	28.05	11.69	103.35
t statistics in parentheses	* p<0.05	** p<0.01	*** p<0.001"							

Note: OLS estimations are reported. Data is from American Time Use Survey's Eating and Health Module from 2006-08 and 2014-16. Income data is from CPS. Regressions weighted by survey weight.

Table 3: Estimated elasticities of leisure type with respect to health and income

Elasticities at mean	Sports	Non-Sports	Television Viewing	Socializing	Arts	Tobacco Use	Relaxation	Games	Computer Use	Hobbies
Excellent Health [a]	0.14	0.144	-0.02	0.004	0.04	-0.15	-0.03	-0.06	-0.02	0.01
Very Good Health [a]	0.12	0.102	-0.27	-0.014	0.08	-0.17	-0.05	-0.05	0.01	0.02
Fair Health [a]	-0.004	-0.012	0.02	0.006	-0.02	0.03	0.02	0.02	0.02	0.002
Poor Health [a]	-0.001	-0.012	0.17	0.006	-0.004	0.04	0.003	0.006	0.01	0.00
Income[a]	0.47	0.15	-0.14	-0.037	0.21	-0.9	-0.18	-0.06	-0.02	-0.03

[a] Evaluated at sample means.

Table 4: Results of joint tests of significance –

	Active leisure: Sports, Non-sports, Arts
TV Viewing	Reject Null
Socializing	Reject Null
Tobacco	Reject Null
Games	Reject Null
Computer Use	Reject Null
Relaxation	Reject Null
Hobbies	Reject Null

Null hypothesis: between leisure activities *i* and *j*

(1) $\beta_i^{Exc\_health}=\beta_j^{Exc\_health}$

(2) $\beta_i^{verygood\_health}=\beta_j^{verygood\_health}$

(3) $\beta_i^{fair\_health}=\beta_j^{fair\_health}$

(4) $\beta_i^{poor\_health}=\beta_j^{poor\_health}$

(5) $\beta_i^{income}=\beta_j^{income}$

Rejection/Non-Rejections of null are at 1% level of significance, values of test statistics and p-values reported in appendix table A1.

Table 5: SUR regressions results for aggregated leisure categories

	(1)	(2)	(3)	(4)
Dependent variable: Leisure Groups (Active and Passive)	Active Leisure		Passive Leisure	
Excellent Health	13.16***	11.12***	-30.43***	-19.89***
	(17.24)	(1.13)	(-12.32)	(4.01)
Very Good Health	6.139***	4.02***	-19.18***	-10.96***
	(9.60)	(0.93)	(-9.28)	(3.05)
Fair Health	-2.180*	-1.41	37.62***	12.24
	(-2.51)	(1.23)	(13.37)	(5.26)
Poor Health	-3.783**	1.57	101.1***	-14.39
	(-2.79)	(3.66)	(23.04)	(11.32)
Predicted Wage		0.302**		-0.69**
		(0.09)		(0.32)
Income	0.0803***	0.05***	-0.500***	-.226***
	(9.69)	(0.01)	(-18.64)	(0.04)
Age	-1.709***	-1.66***	-5.265***	-1.64
	(-19.25)	(0.23)	(-18.33)	(0.76)
Age^2	0.0102***	0.01***	0.0937***	0.03***
	(12.65)	(0.00)	(36.08)	(0.00)
Education	-3.509***	-0.02	4.126**	8.58***
	(-7.79)	(0.02)	(2.83)	(2.32)
Education^2	0.0755***	0.03	-0.244***	-0.37***
	(5.40)	(0.02)	(-5.40)	(0.08)
Age* Education	0.0346***	0.02	-0.0787***	-0.03
	(7.58)	(0.01)	(-5.33)	(0.03)
Gender	-10.42***	-7.9***	-45.19***	-43.85***
	(-20.20)	(0.91)	(-27.08)	(2.68)
Year Fixed Effects	Yes	Yes	Yes	Yes
State Dummies	Yes	Yes	Yes	Yes
Race Dummies	Yes	Yes	Yes	Yes
Metropolitan Area dummy	Yes	Yes	Yes	Yes
Highest Income Dummy	Yes	Yes	Yes	Yes
Number of Children	Yes	Yes	Yes	Yes
Number of Observations	64798	20233	64798	20233
R-Squared	0.03	0.02	0.18	0.05
F	34.25	8.08	209.8	15.43

OLS regression results, standard errors are in parentheses. All 4 models contain dummy variables for 50 states. Models (2) and (4) are on sample of working population only.
***p-value < 0.01, ** p-value < 0.05, * p-value < 0.10.

Table 6: Estimated elasticities of Active and Passive leisure with respect to health and income:

Elasticities at mean	Active Leisure	Passive Leisure
Excellent Health	0.10	-0.01
Very Good Health	0.09	-0.02
Fair Health	-0.01	0.01
Poor Health	-0.01	0.01
Income	0.21	-0.1

Appendix Table A1: Bivariate test statistics (Chi-square(5)) and p-values for aggregation:

	Sports	Non-Sports	Arts	Active Leisure
Non-Sports	87.08 (0.00)			
Arts	15.34 (0.00)	149.55 (0.00)		
TV Viewing	4665.25 (0.00)	4874.90 (0.00)	4538.37 (0.00)	5254.95 (0.00)
Socializing	491.20 (0.00)	632.21 (0.00)	464.89 (0.00)	1015.07 (0.00)
Tobacco	411.09 (0.00)	757.58 (0.00)	273.34 (0.00)	1314.17 (0.00)
Games	360.68 (0.00)	604.19 (0.00)	290.05 (0.00)	1129.64 (0.00)
Computer Use	109.39 (0.00)	329.66 (0.00)	64.95 (0.00)	808.42 (0.00)
Relaxation	1156.53 (0.00)	1446.57 (0.00)	1065.27 (0.00)	1960.90 (0.00)
Hobbies	97.40 (0.00)	224.80 (0.00)	82.78 (0.00)	613.64 (0.00)

Reported values are chi-square test statistics for each pairwise test of health and income. p-values are in parentheses

Appendix Table A2: Wage estimation

Dependent variable: Hourly Wage	
Age	0.35***
	(0.42)
Age^2	-0.003***
	(0.00)
Education	-1.05***
	(0.10)
Education^2	0.07***
	(0.00)
Gender	-1.85***
	(0.13)
Union Membership	Yes
Industry Dummies	Yes
Occupational Dummies	Yes
Race Dummies	Yes
Metropolitan Area dummy	Yes
Highest Income Dummy	Yes
Number of Children	Yes
Number of Observations	20233
R-Squared	0.43
F	34.13

Appendix

Theoretical Model:

$$\max_{A,L} J = U(x, A, P) = U(w(H).(1 - A - P), f(H) \cdot A, P$$

FOCs:

$$J_A = u_x\left(w(H).(1-A-P), f(H).A, P\right) \cdot \left(-w(H)\right) + u_A\left(w(H).(1-A-P), f(H)A, P\right).f(H) = 0$$

$$J_P = u_x\left(w(H).(1-A-P), f(H).A, P\right) \cdot \left(-w(H)\right) + u_P\left(w(H).(1-A-P), f(H)A, P\right) = 0$$

$$\Rightarrow u_A\left(w(H).(1-A-P), f(H)A^*, P^*\right).f(H) = u_P\left(w(H).(1-A-P), f(H)A^*, P^*\right)$$

Assuming utility function to be separable of the following form:

$$U(x, A, P) = u(x) + v(f(H).A, P)$$

FOCs imply that:

$$v_A(f(H)A^*, P^*).f(H) = v_P(f(H)A^*, P^*)$$

$$f(H) = \frac{v_P(f(H)A^*, P^*)}{v_A(f(H)A^*, P^*)}$$

i.e. the Marginal rate of substitution between active and passive leisure is given by $f(H)$.

Next, we compute comparative statics results to find out the effect of health on Active and Passive leisure consumption.

Comparative statics

$$J_{AA}\frac{\partial A}{\partial H} + J_{AP}\frac{\partial P}{\partial H} + J_{AH} = 0$$

$$J_{PA}\frac{\partial A}{\partial H} + J_{PP}\frac{\partial P}{\partial H} + J_{PH} = 0$$

So:

$$\begin{bmatrix} J_{AA} & J_{AP} \\ J_{PA} & J_{PP} \end{bmatrix}\begin{bmatrix} \partial A/\partial H \\ \partial P/\partial H \end{bmatrix} = \begin{bmatrix} -J_{AH} \\ -J_{PH} \end{bmatrix}$$

$$\frac{\partial A^*}{\partial H} = \frac{1}{\Delta}\begin{vmatrix} -J_{AH} & J_{AP} \\ -J_{PH} & J_{PP} \end{vmatrix} = \frac{1}{\Delta}\left(-J_{AH}J_{PP} + J_{AP}J_{PH}\right)$$

$$\frac{\partial P^*}{\partial H} = \frac{1}{\Delta}\begin{vmatrix} J_{AA} & -J_{AH} \\ J_{PA} & -J_{PH} \end{vmatrix} = \frac{1}{\Delta}\left(-J_{AA}J_{PH} + J_{PA}J_{AH}\right)$$

where $\Delta \equiv J_{AA}J_{PP} - J_{AP}J_{PA}$ (assume $\Delta > 0$, to satisfy Second Order Sufficiency condition), and all derivatives are evaluated at the optimal solution.

Partial effects (economizing on notation):

$$J_{AA} = u_{xx} \cdot w^2 + u_{AA} \cdot f^2$$

$$J_{AP} = u_{xx} \cdot w^2 + u_{AP} \cdot f$$

$$J_{PA} = u_{xx} \cdot w^2 + u_{PA} \cdot f$$

$$J_{PP} = u_{xx} \cdot w^2 + u_{PP}$$

$$J_{AH} = u_{xx} \cdot (-w).(-w').(1 - A - P) + v_{AA} \cdot f.f'.A$$

$$J_{PH} = u_{xx} \cdot (-w).(-w').(1 - A - P) + v_{PA}.f'.A$$

$$\frac{\partial A^*}{\partial H} = \left\{ \begin{array}{l} -[u_{xx}.w.w'.(1 - A - P) + v_{AA}.f.f'.A].[u_{xx}.w^2 + u_{PP}] \\ +[u_{xx}.w^2 + u_{AP}.f].[u_{xx}.w.w'.(1 - A - P) + v_{PA}.f'.A] \end{array} \right\} . \frac{1}{\Delta}$$

$$\frac{\partial P^*}{\partial H} = \left\{ \begin{array}{l} -[u_{xx}.w.w'.(1 - A - P) + v_{PA}.f'.A].[u_{xx}.w^2 + u_{AA}.f^2] \\ +[u_{xx}.w^2 + u_{AP}.f].[u_{xx}.w.w'.(1 - A - P) + v_{AA}.f.f'.A] \end{array} \right\} . \frac{1}{\Delta}$$

Therefore, the comparative statics results reflect many factors, including the fact that the health stock changes the productivity of work. One possible avenue to simplify the problem is to treat the amount of time spent at work as fixed and then look at the choice between Active and Passive leisure. However, we do not adopt this approach since the relationship between health and wages is key for this paper and this relationship ultimately determines why one form of leisure might be chosen vis-à-vis the other. Since fixing work ultimately amounts to fixing the wage rate, such an approach may not be advisable.

Therefore, the reduced form solutions for $\frac{\partial A^*}{\partial H} and \frac{\partial P^*}{\partial H}$ are different. We are unable to sign these two expressions since the sign of v_{AP} is unknown. Therefore we are able to conclude that the reduced forms may be written as: $\frac{\partial A^*}{\partial H} = g(H) and \frac{\partial P^*}{\partial H} = q(H)$ and it is clear from the above that in equilibrium Health capital has different effects on Active and Passive Leisure.

Simplifying assumptions on dependence of wages on health, constancy of working hours may be of interest to make intuitive sense of these reduced form solutions. However, this is a key result

from the theoretical model and we use this result for our econometric estimation and later to aggregate different leisure time allocation choices into Active and Passive groups.