Longer Hours and Larger Waistlines? The Relationship between Work Hours and Obesity*

By: Charles Courtemanche

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Abstract:
Additional work hours may lead to weight gain by decreasing exercise, causing substitution from meals prepared at home to fast food and pre-prepared processed food, or reducing sleep. Substitution toward unhealthy convenience foods could also influence the weight of one's spouse and children, while longer work hours for adults may further impact child weight by reducing parental supervision. I examine the effects of adult work hours on the body mass index (BMI) and obesity status of adults as well as the overweight status of children. Longer hours increase one's own BMI and probability of being obese, but have a smaller and statistically insignificant effect on these outcomes for one's spouse. Mothers', but not mother's spouse's, work hours affect children's probability of being overweight. My estimates imply that changes in labor force participation account for only 1.4% of the rise in adult obesity in recent decades, but a more substantial 10.4% of the growth in childhood overweight.

KEYWORDS: work hours, obesity, body weight, employment, labor force

Article:

1 Introduction

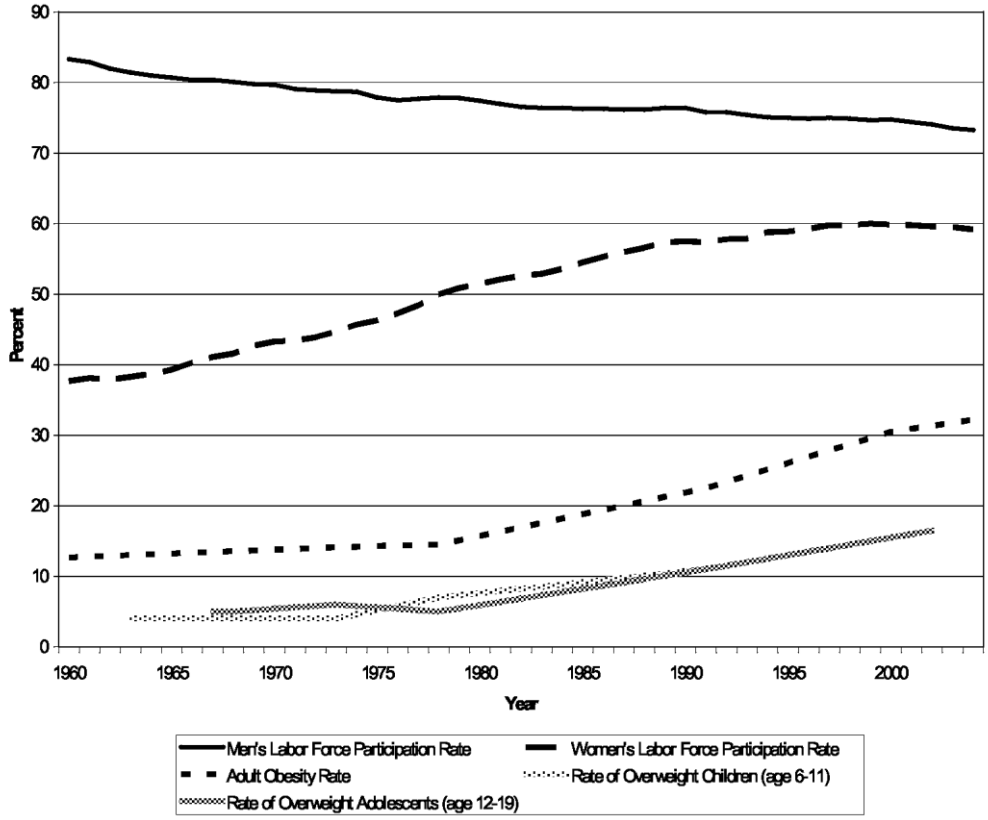
A person is considered clinically obese if he or she has a body mass index (BMI = weight in kg divided by height in meters squared) of 30 or greater. Despite the fact that technological advancements in medicine generally improved the health of the population in the past half-century, the percentage of adults in America who are classified as obese rose dramatically during this time, from 12.8% in 1960-62 to 32.2% in 2003-04 (Flegal et al, 1998; Ogden et al 2006). The outlook is no more encouraging for children and young adults. In 1963-70, 4% of children ages 6-11 and 5% of adolescents ages 12-19 were overweight.[1] By 1999-2002, these percentages had risen to 16% for each (Hedley et al, 2004). Excessive weight has become a critical public health concern. Obesity is now the second-leading cause of preventable deaths in the country behind smoking, accounting for approximately 112,000 deaths per year, and studies have linked it to high blood pressure, diabetes, heart disease, stroke, and a number of other adverse health conditions (Flegal et al, 2005). Consequences of obesity also include an estimated $117 billion in medical and related costs per year (U.S. Department of Health and Human Services, 2001).

Another obvious trend in the U.S. in the second half of the 20th Century was the widespread movement of women into the labor force. In 1950, the labor force participation rate for women ages sixteen and older was 34%; by 2004, this percentage had risen to 59%. While men reduced their market work somewhat in response, the labor force participation rate for the entire adult population still rose from 59% to 66% during this time (Bureau of Labor Statistics, 2007).

The fact that America's weight gain has coincided with the increase in labor force participation (see Figure 1) suggests that a causal relationship between these trends may be possible. Weight gain is caused by an imbalance between calories consumed and calories expended. If an individual works more hours, her leisure time drops, which could increase her weight through three mechanisms. First, she might exercise less, decreasing calories

expended and leading to weight gain. Second, she might devote less time to food preparation, causing a substitution from home-prepared meals to unhealthy convenience food, such as fast food and pre-prepared processed food. This substitution could increase caloric intake, as a variety of research links a higher frequency of eating fast food to greater consumption of calories, fat, and saturated fat (i.e. Satia et al, 2004), and also to obesity (i.e. Jefferey et al, 2006). Chou et al (2004) found that both an increase in restaurant prevalence and a decrease in restaurant price were associated with higher body weights, further suggesting that eating out leads to weight gain. A third potential mechanism is sleep. Additional work may reduce time available for sleep, and research suggests that sleep deprivation is associated with weight gain (i.e. Gangwisch et al, 2005; Taheri et al, 2004). While it not clear if this relationship is causal, short sleep duration appears to lead to changes in hormone levels — reduced leptin and elevated ghrelin — that are likely to increase appetite and therefore caloric intake (Taheri et al, 2004).

Figure 1 – Trends in Labor Force Participation, Adult Obesity, and Overweight Children



Sources: Bureau of Labor Statistics (2007), Flegal et al (1998), Ogden et al (2006), and Hedley et al (2004). Obesity and overweight data are not reported annually; values for missing years are interpolated.

Working longer hours could also impact the weights of an individual's spouse and children. Since families tend to eat together, if one family member substitutes toward unhealthy convenience food the others might as well. Also, if a person works more her spouse and children may have to perform a larger share of the household duties and therefore have less time for exercise and sleep. Child weight could further being affected through a drop in parental supervision. Older children may be left unsupervised while a parent works, and they may make more unhealthy eating and exercise decisions than if their choices were monitored. Parents are less likely to leave younger children alone, but baby-sitters and day-care workers may not value the long-term health of a child as much as the child's parent.

In this paper, I examine the relationship between adult work hours and the BMI and obesity status of adults as well as the overweight status of children. Applying long differencing methods to panel data from the National Longitudinal Survey of Youth (NLSY) and NLSY Child Supplement (NLSYCS), I find that an increase in a man or woman's work hours increases the person's own BMI and probability of being obese. The effect on one's spouse is positive as well in most specifications but smaller and statistically insignificant. I also find that mothers', but not fathers', work hours affect the probability of being overweight of children. My estimates imply that if all U.S. adults permanently increase their work weeks by 10 hours, adult obesity and childhood overweight would increase by 4.1 % and 11.1 %, respectively. The results also suggest that changing employment patterns account for only 1.4% of the rise in adult obesity between 1961 and 2004 but a more substantial 10.4% of the increase in overweight children between 1968 to 2001.

2 Literature Review

When studying reasons for America's rising obesity rate, economists have placed much of the blame on technological progress. Philipson and Posner (1999) suggested that technology increased the efficiency of food production, leading to lower prices and therefore more food consumption, while also causing jobs to be much less physically strenuous, meaning that people burn fewer calories at work. Both of these changes widen the gap between calories consumed and calories burned, leading to a society-wide rise in weight. Lakdawalla and Philipson (2002) found empirical evidence supporting this theory.

Cutler et al (2003) argued that technological advances have lowered the time costs of food preparation and cleaning, leading to increased food consumption. These innovations, which include vacuum packing, improved preservatives, deep freezing, artificial flavors, and microwaves, allow food to be mass-prepared far from the time and place of consumption. Though decreases in opportunity costs are typically beneficial, the authors show that if people have self-control problems, as modeled by a hyperbolic discount rate while eating, then for some people these advances actually reduce utility.

Another possible way in which technological progress affected obesity is by improving labor market opportunities, thereby increasing work hours, particularly for women. Three recent papers examined the effect of maternal employment on childhood obesity. Using data from the NLSY matched with the NLSYCS, Anderson, Butcher, and Levine (2003) (ABL) found that a mother working 10 additional hours per week over the course of a child's life (ages 3 to 11) is associated with a 1 percentage point increase in the probability that the child is overweight. ABL argued that estimates of the work hour effect could suffer from unobserved heterogeneity. Mothers who work may simply be those who are less concerned with their children's health, creating a spurious negative relationship. On the other hand, ambitious mothers may both work and value health, biasing the effect upward. ABL therefore implemented long differences and instrumental variables approaches, but these estimates were similar to those using a simple linear probability model, suggesting that the extent of the unobserved heterogeneity is minimal.

Ruhm (2004) estimated the relationship between a mother's work hours and several outcomes for children ages 10 and 11, including body weight. He usesd the same NLSYCS data as ABL. Ruhm found that 20 additional mother's work hours per week over the course of the child's life were associated with approximately a 2 percentage point increase in the child's probability of being overweight and a 3 percentage point increase in its probability of being at risk of becoming overweight (BMI above the 85th percentile). He also showed that the effect is stronger for children in higher socioeconomic status families.

Fertig et al (2006) attempted to determine the mechanisms through which maternal employment affects childhood obesity. Using data from the Child Development Supplement of the Panel Study of Income Dynamics, they found that mother's work hours affect children's weight primarily by influencing supervision and nutrition.

The relationship between work hours and adult weight is not as well explored. Chou et al (2004) used data from the Behavioral Risk Factor Surveillance System (BRFSS) to estimate the relationship between a variety of state-

level characteristics and weight. In the working paper version of this paper (2002), they also found a correlation between state-level measures of hours worked and wages and the weight of individuals living in the state.[2] They interpreted this as evidence that improved labor market opportunities, reflected by the movement of women into the labor force, have contributed to the growth in obesity. They hypothesized that improved earning potential led to more work hours and therefore less time for food preparation, stimulating demand for convenience food. In an effort to explain his finding that smoking and obesity fall in recessions, Ruhm (2005) conducted a similar estimation of the relationship between state-level work hours and individual weight and obtained similar results. Ko et al (2007) found a positive association between work hours and BMI in adults in Hong Kong with cross-sectional data. However, the study did not make an attempt to distinguish between correlation and causality, and the authors wrote that "further studies are needed to investigate the underlying mechanisms of this relationship... " (p. 254).

Lakdawalla and Philipson (2007) used NLSY panel data to study a related but different question: how do the physical demands of one's job affect body weight? They showed that working at sedentary or strength demanding (and therefore muscle building) occupations is associated with a higher weight than working at fitness demanding occupations.

In this paper, I contribute to the literature primarily by providing a more complete analysis of the link between work hours and adult weight. To my knowledge, this is the first paper to estimate the effect of individual-level work hours on adult body weight using panel data to eliminate time-invariant sources of omitted variable bias in the estimators. Additionally, I differentiate between work hour effects on the basis of gender, marital status, spouse work status, and employment sector. Finally, I show that work hours affect only the weight of individuals who are at risk for obesity, suggesting that the effect of work hours on weight is particularly hazardous to health.

My primary contribution to the childhood obesity literature lies in exploring the impact of mothers' spouses' work hours, instead of only mothers' work hours, on child weight. In response to increases in female employment, the percentage of adult men who work fell from 83% in 1950 to 73% in 2004 (Bureau of Labor Statistics, 2007). If men are perfect substitutes for women in terms of child care, the effect of more women working on the prevalence of overweight children would be partially offset by the fact that more men stay at home. I also contribute by utilizing a broader range of data than previous authors, as I include children ages 3 to 17 as well as four more waves of NLSY data than ABL (1998, 2000, 2002, and 2004).

3 Data

For regressions of adult body weight, I use data from the 1979 cohort of the National Longitudinal Survey of Youth. The NLSY includes data from 6,111 randomly-chosen U.S. youths, plus a supplemental sample of 5,295 minority and economically disadvantaged youths and 1,280 military youths. The NLSY first conducted interviews in 1979, at which time all respondents were between fourteen and twenty-two years of age. Subsequent interviews occurred each year until 1994, and then every two years until 2004. The respondents' reported their weight in 1981, 1982, 1985, 1986, 1988, 1989, 1990, 1992, 1993, 1994, 1996, 1998, 2000, 2002, and 2004 and their height in 1981, 1982, and 1985. Given the age of respondents, I assume height in 1985 to be adult height and use it as height for all subsequent years. The long differences models utilized in this paper —described in section 4.1— restrict the sample to the years 1994 and later. Although the retention rate of the NLSY79 was high, not all youths were followed for the duration of the sample; therefore, my data are an unbalanced panel. After dropping pregnant women as well as observations with missing data, my sample consists of 7,674 individuals and 22,444 observations.[3] Table 1 reports summary statistics for variables used in the adult regressions.

I obtained data on children from the NLSY79CS, which features interviews with children of mothers found in the NLSY79. Children's height and weight were only recorded in even-numbered years from 1986-2004; therefore, these are the years included in my sample. Other variables used in regressions of children's weight are information about the child's mother matched from the NLSY.[4] The sample for the baseline long differences

model used in section 5 consists of each child's last observation before turning 18, since at that age young adults become less likely to live with their parents. After eliminating observations with missing data, the sample size is 7,261. Table 2 summarizes the variables taken from the NLSYCS.

The first dependent variable in my adult regressions is body mass index, which is equal to weight in pounds divided by height in inches squared, multiplied by 703. Following convention in the literature, I also use a binary variable for whether or not the individual is obese. The average BMI in the sample is 27.4, while the obesity rate is 25.8%. Using BMI for children is inappropriate since the medically optimal BMI is different for children and young adults of different ages. For example, a 10-year-old boy is overweight if his BMI is above 22, while a 15- year-old boy would not be overweight until his BMI reached 27. Therefore, for regressions of child weight, my dependent variable is whether or not the child is overweight, which I construct using age- and gender-specific CDC growth charts.[5] 14.3% of the sample is overweight. My independent variables of interest are the person's (child's mother in children's regressions) average hours worked per week since the last interview and spouse's average hours worked per week in the past year. Following ABL, I use units of 10 hours. The sample means for hours and spouse's work hours (in units of 10) are 3.7 and 2.3, respectively. The mean for spouse's work hours is smaller because I impute values of zero for single people.

Table 1 – Summary Statistics – Adults

Variable	Description	Mean (Std. Dev.)
BMI	Body mass index	27.445 (5.562)
Obese	1 if BMI$\geq$30 kg/m^2 and 0 otherwise	0.258 (0.438)
Work Hours	Average number of hours, in tens, worked per week since previous interview	3.691 (1.943)
Spouse's Work Hours	Average number of hours, in tens, worked per week by spouse in the previous year; 0 if the respondent is unmarried	2.279 (2.132)
Health Limitations	1 if amount or type of work is limited by health	0.109 (0.311)
Household Wage	Real (1982-84 dollars) household income divided by the sum of own and spouse's work hours; 0 if this sum is 0	15.198 (125.409)
Highest Grade Completed	Respondent's highest grade completed	13.489 (2.514)
Married	1 if married	0.655 (0.476)
Age	Age in years	39.985 (3.368)
Number of Children	Number of children ever had	1.731 (1.337)
White Collar	1 if works in a "white collar" occupation	0.436 (0.496)
Blue Collar	1 if works in a "blue collar" occupation	0.296 (0.456)
Service	1 if works in a "service" occupation	0.079 (0.270)
At Risk	1 if respondent had BMI$\geq$25 in 1985	0.517 (0.500)

Note: All summary statistics are weighted using the NLSY sampling weights.

Table 2 – Summary Statistics – Children

Variable	Description	Mean (Std. Dev.)
Overweight	1 if the child is classified as "overweight"	0.143 (0.351)
Child's Age	Child's age in years	13.690 (3.475)
Children	Number of children under age 18 living in the household of the mother	2.278 (1.188)
Mother Overweight	1 if the child's mother is overweight or obese	0.530 (0.499)
Mother Obese	1 if the child's mother is obese	0.257 (0.437)

See note for table 1.

In some regressions, I group hours worked by occupation type: blue collar, white collar, or service. I consider an individual to be "blue collar" if her primary occupation is classified as "craftsman, foremen, and kindred;" "armed forces;" "operatives and kindred;" "laborers, except farm;" "farmers and farm managers;" or "farm laborers and foremen." I label an individual "white collar" if her occupation is "professional, technical, and kindred;" "managers, officials, and proprietors;" "sales workers;" or "clerical and kindred" and "service" if her occupation is "service workers, except private household" or "private household."

In other regressions, I stratify the sample on the basis of overweight status (BMI $\geq$ 25) at the beginning of the panel in order to discern whether the impact of additional work hours on weight is stronger for people who were already at risk of becoming obese. To do this, I create an indicator variable "at risk" that is equal to 1 if the individual had a BMI of at least 25 in 1985. I use 1985 as the beginning year instead of 1981 or 1982 because all respondents were adults in 1985. 52% of the sample is classified as "at risk."

The wide range of questions asked by the NLSY survey allows me to include as control variables other factors that could be expected to influence adult weight: hourly rate of pay, highest grade completed, marital status, age, number of children, and whether or not the respondent has any health conditions that limit the amount or type of work she can perform.[6] I do not include time-invariant controls such as race, gender, and intelligence because the differencing estimation strategy utilized in this paper eliminates the variation in these variables. In regressions of children's weight, I include these same characteristics as well as indicator variables for whether or not the child's mother is overweight or obese.

4 Adults

4.1 Models

I conduct a reduced-form estimation of the relationship between own and spouse work hours and body mass index and obesity status. I estimate a reduced-form model — as opposed to a structural model in which weight is a function of eating at restaurants, exercise, and sleep, which are in turn functions of own and spouse's work hours — for three reasons. First, the NLSY contains very limited information on the frequency of eating out, amount of exercise, and amount of sleep. Second, even if detailed information on these variables was available, estimating the structural model would require a third instrument in addition to own and spouse's work hours. Third, it is possible that eating at restaurants, exercise, and sleep are not the only mechanisms through which work hours affect weight, in which case the exclusion restrictions in a structural model would not hold. For example, working more may create stress, which has been linked to overeating and weight gain (Greeno and Wing, 1994). Also, additional work hours could affect weight by creating additional income. (Since I include hourly rate of pay as a control instead of income, the reduced-form model allows part of the effect of work hours on weight to occur through changes in income.) Finally, working more may cause weight to fall simply by leaving less time for eating.

I estimate the impacts of own and spouse's work hours on weight using a strategy designed to address two important issues. First, body weight is a capital stock in that it depreciates over time but is replenished by new "investment" in the form of perpetual caloric intake. If an individual changes her daily eating or exercise habits, her weight will not change all at once. Instead, it will change slowly, eventually reaching a new steady state after months or possibly years.[7] Weight therefore depends on both contemporaneous and lagged values of its determinants.

In the maternal employment and child weight literature, ABL and Ruhm (2004) addressed this issue by converting independent variables to averages of their values over the child's entire life. Since I focus on adults, whom I do not observe from birth, I apply a variation of this approach by averaging over the individual's entire adult life, which I define as being at least 23 years old.[8] Formally, define the average of variable *Z* over individual *i*'s entire adult life up to period *t* as

$$\overline{Z}_{it} = \frac{\sum_{j=1}^{t} Z_{ij} * WK_{ij}}{\sum_{j=1}^{t} WK_{ij}} \tag{1}$$

where WK_{ij} is the number of weeks since the respondent's last interview (or 52 for the first interview).

A second issue is that work hours are endogenous, so ordinary least squares estimators of the effects of own and spouse's work hours on weight may be biased even after including control variables. People who are ambitious may both work a large number of hours and maintain a healthy weight, biasing the estimator for own work hours downward. Since people tend to choose spouses who are similar to themselves, the estimator for spouse's work hours could also suffer from bias. Additionally, hard-working, financially successful individuals may marry thin spouses, in which case the estimator for spouse's work hours may be biased downward.

To account for sources of endogeneity that are constant over time, ABL used a long differences approach in which they differenced between the child's last and first years in the sample. Since the independent variables of interest were averages over the child's life, their differences reflected changes in the variable averages over time. Because they used children in the age range 3 to 11, the differences were over up to an eight-year period. Since weight likely responds gradually to changes in work hours, a long differences approach may be more appropriate than first differences or fixed effects. ABL also argued that long differencing reduces the extent of bias from measurement error. In order to apply a similar estimation technique to adults, I difference between the current year and eight years ago. Since most adults are in the sample for twenty years, differencing between the last and first years would likely be excessive in accounting for the gradual nature of weight changes. Also, by allowing each individual to be in the sample more than once, I retain the degrees of freedom and extra information from the additional observations.[9] I restrict the sample to observations where the person was at least 28 years old in the initial period. This ensures that the averages in each initial period are based on at least five years' worth of data, and therefore not driven by one atypical year.[10]

My long differenced regression equation is:

$$\Delta W_{it} = \beta_0 + \beta_1 \Delta \overline{H}_{it} + \beta_2 \Delta \overline{HS}_{it} + \beta_3 \Delta AGE_{it} + \beta_4 \Delta \overline{X}_{it} + \Delta T_t + \Delta \varepsilon_{it} \tag{2}$$

where W_{it} is a measure of weight (BMI or obesity status)[11] for individual *i* in year *t*; $\overline{H}$ is average weekly work hours in units of 10; $\overline{HS}$ is spouse's average weekly work hours in units of 10; $\overline{X}$ is a set time-variant controls that includes marital status, health limitations, hourly rate of pay, education, and number of children; age is the respondent's age (which I include separately since it is not averaged); and *T* is a year fixed effect.

$\hat{\beta}_1$ and $\hat{\beta}_2$ are unbiased estimators under the assumption that changes in work hours are uncorrelated with changes in the error term. While I cannot be completely certain of the validity of this assumption, the most likely sources of bias, such as ambition, are relatively stable over time. Also, failure to account for changes in

ambition over time should result in downward bias, inwhichcase my results are a lower bound.[12] Assigning a causal interpretation to $\hat{\beta}_1$ and $\hat{\beta}_2$ also requires the assumption that work hours affect weight instead of the other way around. Reverse causality is a potential concern, as obesity may reduce work hours, both through health limitations and labor market discrimination.[13] Controlling for health limitations and modeling weight as a function of average work hours over a long time period mitigate this concern to some degree. Additionally, $\hat{\beta}_1$ would actually understate the work hour effect if obese people work less than others because of discrimination. Furthermore, ABL employed both long differences and instrumental variable approaches and obtained similar results with each, suggesting that a long differences estimator of the effect of mother's work hours on child weight does not suffer from omitted variable bias or reverse causality. Nonetheless, I cannot be certain that these findings apply to adult weight.

A limitation with averaging the independent variables is each period is weighted equally. Since body weight is a depreciating capital stock, recent values of the independent variables may influence weight more strongly than values in the distant past. On the other hand, eating and exercise habits may not respond immediately to changes in the regressors, in which case past values would have more predictive power than contemporaneous values. I therefore also estimate a model that relaxes the assumption that the independent variables have the same effects in all periods. I replace each averaged variable with three averaged variables: the average over the current year and last year, the average over two and three years ago, and the average over the remainder of one's adult life. 14 Formally, for a variable Z, define the three averages $\overline{Z}_1$, $\overline{Z}_2$, and $\overline{Z}_3$ as

$$\overline{Z}_{1it} = \frac{\sum_{j=0}^{1} Z_{i,t-j} * WK_{i,t-j}}{\sum_{j=0}^{1} WK_{i,t-j}} \tag{3}$$

$$\overline{Z}_{2it} = \frac{\sum_{j=2}^{3} Z_{i,t-j} * WK_{i,t-j}}{\sum_{j=2}^{3} WK_{i,t-j}} \tag{4}$$

$$\overline{Z}_{3it} = \frac{\sum_{j=1}^{t-4} Z_{ij} * WK_{ij}}{\sum_{j=1}^{t-4} WK_{ij}} \tag{5}$$

The regression equation becomes

$$\Delta W_{it} = \beta_0 + \sum_{j=1}^{3} \beta_{1j}\ \Delta\overline{H}_{jit} + \sum_{j=1}^{3} \beta_{2j}\ \Delta\overline{HS}_{jit} + \beta_3 \Delta AGE_{it} + \sum_{j=1}^{3} \beta_{4j}\ \Delta\overline{X}_{jit} + \Delta T_t + \Delta\varepsilon_{it} \tag{6}$$

Comparing the coefficient estimates for the three averages will help to understand the timing of the effect. For instance, if $\hat{\beta}_{11}$ is large but $\hat{\beta}_{12}$ and $\hat{\beta}_{13}$ are close to zero, then the entire work hour effect occurs quickly. If, however, $\hat{\beta}_{11}$ and $\hat{\beta}_{12}$ are small while β_{13} is large, the effect is mostly delayed. The long-run effect of, for example, a permanent 10-hour-per-week increase in work hours is given by $\hat{\beta}_{11} + \hat{\beta}_{12} + \hat{\beta}_{13}$. In equation (2), the long-run effect of a permanent 10-hour-per- week increase in work hours is $\hat{\beta}_1$. If $\hat{\beta}_{11} + \hat{\beta}_{12} + \hat{\beta}_{13}$ differs substantially from $\hat{\beta}_1$, then the assumption that all periods are weighted equally is likely leading to a misleading estimate of the long-run effect in (1).

(2) and (6) both assume that the effect of one's work hours on weight is the same for married and single people. However, people who are married have a spouse to assist with meal preparation; therefore, the work hour effect may be smaller for them than for singles. Alternatively, marrying often introduces a new set of responsibilities, ranging from home ownership to raising children. If married individuals face tighter time constraints than singles, marrying may exacerbate the work hour effect. (2) and (6) also assume that the effect of one's work hours on weight does not depend on how much one's spouse works, and that the effect of spouse's work hours on weight does not depend on own work hours. If a person whose spouse does not work begins to work more, the spouse may be able to compensate by handling more of the food preparation duties. If the spouse also

works, this becomes more difficult, suggesting that the work hour effect depends on spouse's work hours, and (analogously) that the spouse work hour effect depends on own work hours.

I next relax these assumptions by interacting work hours with marital status and spouse's work hours and adding these terms to the baseline model given by (2):

$$\Delta W_{it} = \beta_0 + \beta_1 \Delta \overline{H}_{it} + \beta_2 \Delta \overline{HS}_{it} + \beta_3 \Delta(\overline{HWK}_{it} * \overline{UNMARRIED}_{it}) + \beta_4 \Delta(\overline{H}_{it} * \overline{HS}_{it}) + \beta_5 \Delta AGE_{it} + \beta_6 \Delta \overline{X}_{it} + \Delta T_t + \Delta \varepsilon_{it} \quad (7)$$

The effect of ten additional work hours per week is $\beta_1 + \beta_3$ for singles, β_1 for married people whose spouses do not work, and $\beta_1 + 4\beta_4$ for married people whose spouses work 40 hours per week. The spouse work hour effect is β_2 for people who do not work and $\beta_2 + 4\beta_4$ for those who work 40 hours per week.

In the remaining regressions for adults, I further investigate potential heterogeneity of the work hour effects. First, I run separate regressions for men and women to determine if the effects vary on the basis of gender. Second, I estimate the baseline model (2) restricting the sample to people with a work history ($\overline{H} > 0$) in order to isolate the effects on workers. Next, I differentiate between the effects of work hours on the weight of people who were "at risk" of obesity at the start of the panel and those who were not by dividing the two groups into subsamples. If working only increases the weight of people who initially were within the healthy weight range, then such a weight gain may not worsen health. Gaining weight could even improve the health of people who were initially underweight. Alternatively, if working only increases the weight of those who were already at risk of obesity, then the effects on health would be especially severe. Next, I differentiate between the work hour effects of white collar, blue collar, and service workers using the following regression equation:

$$\Delta W_{it} = \beta_0 + \beta_1 \Delta(\overline{H}_{it} * \overline{WHITEC}_{it}) + \beta_2 \Delta(\overline{H}_{it} * \overline{BLUEC}_{it}) + \beta_3 \Delta(\overline{H}_{it} * \overline{SERVICE}_{it}) + \beta_4 \Delta \overline{HS}_{it} + \beta_5 \Delta AGE_{it} + \beta_6 \Delta \overline{X}_{it} + \Delta T_t + \Delta \varepsilon_{it} \quad (8)$$

where $\overline{WHITEC}$ represents the proportion of time since age 23 the respondent has held a white collar job, $\overline{BLUEC}$ represents a blue collar job, and $\overline{SERVICE}$ represents a service occupation. A finding that $\beta_3 > \beta_2$ and $\beta_1 > \beta_2$ would provide evidence that shifts in employment over time from blue collar to white collar and service professions may have increased the average work hour effect.

4.2 Results

Tables 3 and 4 report the coefficient estimates for the work hour variables in the regressions given by (2), (6), and (7).[15] Table 3 uses BMI as the dependent variable, while table 4 uses obesity status. The "baseline" column indicates the baseline long differences regression (2), "3 averages" indicates the regression (6) that includes three averages for the independent variables, and "interactions" indicates the regression (7) that adds the interaction terms $\overline{H} * \overline{UNMARRIED}$ and $\overline{H} * \overline{HS}$. At the bottom of the tables, I compute the estimated long-run effects of work hours for people who are single, married with a spouse who does not work, and married with a spouse who works 40 hours per week, as well as the long-run effects of spouse's work hours for people who work and those who do not work. In brackets, I convert the coefficient estimates to pounds at the sample mean height of 67.89 inches in order to allow for easier interpretation.

In the baseline BMI regression, a permanent 10 hour per week increase in work hours is associated with a statistically significant increase of 0.18 units BMI, or 1.2 pounds. Since this model assumes that the work hour effect is homogenous, the effects on single people, married people with spouses who do not work, and married people whose spouses work are all the same. 10 additional spouse's work hours increase weight by 0.08 units BMI, or 0.53 pounds. The p-value is 0.105, so spouse's work hours are not quite significant at the 10% level. Again, the model assumes homogeneity, so the effect of spouse's work hours is the same regardless of one's work status.

In the BMI regression with three averages, the estimates for all three own work hours variables are positive. 10 additional hours over the past two years increase BMI by a statistically insignificant 0.025 units, 10 additional hours over the two years before that increase BMI by a significant 0.031 units, and 10 additional hours over all years before that increase BMI by a significant 0.086 units.

Table 3 – Effects of Work Hours on Adults' BMI

	Baseline	3 Averages	Interactions
Work Hours (units of 10)	0.183 (0.079)**	–	0.216 (0.110)**
Spouse's Work Hours (units of 10)	0.081 (0.050)	–	0.029 (0.111)
Work Hours in t and $t-1$	–	0.025 (0.016)	–
Work Hours in $t-2$ and $t-3$	–	0.031 (0.016)**	–
Work Hours in up to $t-4$	–	0.086 (0.034)**	–
Spouse's Work Hours in t and $t-1$	–	0.028 (0.016)*	–
Spouse's Work Hours in $t-2$ and $t-3$	–	0.020 (0.015)	–
Spouse's Work Hours in up to $t-4$	–	0.022 (0.041)	–
Unmarried*Work Hours	–	–	−0.141 (0.144)
Work Hours*Spouse's Work Hours	–	–	0.016 (0.029)
Number of Observations	22,444	17,932	22,444
R^2	0.005	0.015	0.006
Effect of 10 hours if single	0.183 (0.079)** [1.199]	0.142 (0.039)*** [0.934]	0.075 (0.110) [0.491]
Effect of 10 hours if married and spouse does not work	0.183 (0.079)** [1.199]	0.142 (0.039)*** [0.934]	0.216 (0.110)** [1.419]
Effect of 10 hours if married and spouse works 40 hours	0.183 (0.079)** [1.199]	0.142 (0.039)*** [0.934]	0.281 (0.117)** [1.843]
Effect of 10 spouse's hours if person does not work	0.081 (0.050) [0.534]	0.070 (0.045) [0.456]	0.029 (0.111) [0.193]
Effect of 10 spouse's hours if person works 40 hours	0.081 (0.050) [0.534]	0.070 (0.045) [0.456]	0.094 (0.053)* [0.617]

Notes: *** represents statistically significant at the 1% level; ** 5% level; * 10% level.All regressions include the controls and year effects. Heteroskedasticity-robust standard errors, clustered by individual, are in parentheses. Observations are weighted using the average of the NLSY sampling weights from the two periods used to create the differences. Brackets contain conversions to pounds at the sample mean height.

Table 4 – Effects of Work Hours on Adults' P(Obese)

	Baseline	3 Averages	Interactions
Work Hours (units of 10)	0.013 (0.006)**	–	0.020 (0.012)*
Spouse's Work Hours (units of 10)	0.0006 (0.006)	–	0.004 (0.012)
Work Hours in t and $t-1$	–	0.001 (0.002)	–
Work Hours in $t-2$ and $t-3$	–	0.004 (0.002)*	–
Work Hours in up to $t-4$	–	0.007 (0.004)	–
Spouse's Work Hours in t and $t-1$	–	0.002 (0.002)	–
Spouse's Work Hours in $t-2$ and $t-3$	–	−0.0001 (0.002)	–
Spouse's Work Hours in up to $t-4$	–	−0.002 (0.005)	–
Unmarried*Work Hours	–	–	−0.011 (0.013)
Work Hours*Spouse's Work Hours	–	–	−0.001 (0.003)
Number of Observations	22,444	17,932	22,444
R^2	0.002	0.006	0.002
Effect of 10 hours if single	0.013 (0.006)**	0.012 (0.005)**	0.009 (0.008)
Effect of 10 hours if married and spouse does not work	0.013 (0.006)**	0.012 (0.005)**	0.020 (0.012)*
Effect of 10 hours if married and spouse works 40 hours	0.013 (0.006)**	0.012 (0.005)**	0.016 (0.008)**
Effect of 10 spouse's hours if person does not work	0.0006 (0.006)	−0.0005 (0.005)	0.004 (0.012)
Effect of 10 spouse's hours if person works 40 hours	0.0006 (0.006)	−0.0005 (0.005)	0.0003 (0.006)

See notes for table 3.

The evidence therefore suggests that the work hour effect is largely delayed. The total long-run effect on BMI is a statistically significant 0.142 units, and the effect is assumed to be the same for all individuals. 0.142 is well within one standard deviation of the estimated long-run effect from the baseline regression, so there is no evidence that weighting each period equally in the baseline regression led to a misleading estimate. The coefficient estimates for each of the three spouse's work hour variables are between 0.02 and 0.03, and one of the three is significant at the 10% level. The total long-run effect, which is assumed the same for everyone, is a slightly insignificant 0.07 units BMI. This is again similar to the long-run effect estimated in the baseline model.

Adding the interaction terms reveals that the effect of own work hours on BMI is weaker for people who are single, implying that the impact of facing additional constraints on time after marrying outweighs the impact of having an additional person to share with the food preparation. The effect of 10 additional work hours over an individual's entire adult life is 0.5 pounds for singles, 1.4 pounds for people who are married to a spouse who does not work, and 1.8 pounds for people who are married to a spouse who works. The interaction term work hours*spouse's work hours is positive, as expected. The effect of 10 additional spouse's work hours is 0.2 pounds for people who do not work and 0.6 pounds for people who work. Neither interaction term is significant, however, so these findings are inconclusive.

In the baseline obesity status regression, 10 work hours increase P(Obese) by a statistically significant 1.3 percentage points. Spouse's work hours, though, have essentially no effect on P(Obese). Using three averages,

the majority of the effect of own work hours is again largely delayed. The total long-run effect of 10 work hours on P(Obese) is a significant 1.2 percentage points. The coefficient estimates for all three spouse work hour variables are small and insignificant, and the total long-run effect is close to zero. In the regression that adds the interaction terms, the sign of the coefficient estimate for unmarried*work hours is again negative, while that for work hours*spouse's work hours is now negative but very small. Both interaction terms are statistically insignificant. The effect of 10 additional work hours per week on the probability of becoming obese is 0.9 percentage points for singles, 2.0 percentage points for married people with non-working spouses, and 1.6 percentage points for married people with working spouses. The spouse work hour effect is 0.4 percentage points for those who do not work and 0.03 percentage points for those who do.

Tables 5 and 6 show the results for the subsamples. As discussed in the preceding paragraphs, the total effects estimated using three averages were similar to those obtained using only one average, while the impacts of the interaction terms were inconclusive. I therefore use the simplest model, baseline long differences, for all subsample regressions. Table 5 divides the sample into women and men. The work hour effect appears stronger for women than men when using BMI as the dependent variable, but becomes stronger for men when obesity status is used. Neither difference is statistically significant at the 5% level. For both genders, one's spouse working causes a modest increase in BMI but essentially no change in P(Obese). In short, there does not appear to be an obvious difference in how own or spouse's work hours impact the weight of the two genders.

Table 6 shows the results for people with positive average work hours, people who were overweight (or obese) at the beginning of the panel and were therefore "at risk" for obesity, and those who were not. Only 353 individuals have no average work hours, so the estimates for the sample of workers are very similar to those for the full sample. The effects of own work hours on the BMI of the "at risk" group are positive, large, and significant. 10 additional work hours are associated with a weight gain of 0.3 8 units BMI, or 2.5 pounds at the sample mean height. However, the effects on the BMI of people who did not begin the panel overweight are small and insignificant. One possible explanation for the discrepancy is that people who place a high value on health may make a special effort to maintain healthy eating and exercise habits after their work hours rise. For example, they may still eat more fast food but choose the healthiest items on the menu. However, it is also possible that all people make less healthy decisions, but only those who are genetically prone to weight gain actually gain a noticeable amount of weight. In either case, the fact that the impact of work hours on weight is substantially stronger for people who are at risk for obesity means that the work hour effect is particularly hazardous to public health.

Table 5 – Women and Men

	Women		Men	
	BMI	Obese	BMI	Obese
Work Hours (units of 10)	0.278	0.006	0.138	0.017
	(0.131)**	(0.008)	(0.095)	(0.009)**
Spouse's Work Hours (units of 10)	0.016	0.006	0.081	−0.002
	(0.103)	(0.009)	(0.060)	(0.008)
Number of Observations	10,196	10,196	12,248	12,248
R^2	0.007	0.002	0.006	0.003

See notes for table 3.

Table 6 – Workers, At Risk for Obesity, and Not at Risk for Obesity

	Workers		At Risk	Not at Risk
	BMI	Obese	BMI	BMI
Work Hours (units of 10)	0.178	0.013	0.380	0.012
	(0.079)**	(0.006)**	(0.148)***	(0.054)
Spouse's Work Hours (units of 10)	0.085	0.0006	0.122	0.048
	(0.050)*	(0.006)	(0.082)	(0.057)
Number of Observations	22,091	22,091	12,357	10,087
R^2	0.005	0.002	0.007	0.006

See notes for table 3.

In table 7, I report results for the regressions with work hours grouped by occupation type. The work hour effect does appear strongest for white-collar workers, but the effect on blue-collar workers is also positive. Only service workers do not appear affected by additional work. When interpreting these findings, note that BMI does not distinguish between fat and muscle mass. It is possible that blue-collar workers, who often engage in strenuous on-the-job exercise, may actually be adding muscle instead of fat. In contrast, the jobs of service workers likely involve only low-intensity exercise, such as walking, which builds little or no muscle. If the weight gain of blue-collar workers is in fact muscle instead of fat, then my results may overstate the health consequences of additional work.

Table 7 – Hours Grouped by Occupation Types

	BMI	Obese
Work Hours*White Collar (units of 10)	0.166	0.014
	(0.097)*	(0.006)**
Work Hours*Blue Collar (units of 10)	0.146	0.009
	(0.076)*	(0.007)
Work Hours*Service (units of 10)	0.061	−0.005
	(0.100)	(0.010)
Number of Observations	22,428	22,428
R^2	0.005	0.002

See notes for table 3.

5 Children

5.1 Models

I next analyze the effect of parents' work hours on the overweight status of children and young adults. My estimation approach for children is virtually identical to the long differences strategy used by ABL, except for three main changes. First, they only utilize up to the 1996 NLSY wave, so my data set includes an additional four waves: 1998, 2000, 2002, and 2004. Second, I include mother's spouse's work hours as a regressor in addition to mother's work hours. Third, my sample consists of all children and young adults between the ages of 3 and 17, whereas their sample excludes those over 11.

I estimate a linear probability model using whether or not the child is overweight (O) as the dependent variable. I again convert the independent variables (besides age and the year effects) to averages according to equation (1). I average over all periods, up to and including the current period, for which the child is observed. Most children are observed from birth; for these children, the independent variables are averages over their entire lives. The model is long differenced, using the child's first observation after turning three as the "initial period" and her last observation before turning eighteen as the "final period." Few children are in the sample from birth to the age of eighteen; the average length of time between initial and final periods is seven years. The regression equation is

$$\Delta O_{it} = \beta_0 + \beta_1 \Delta\overline{H}_{it} + \beta_2 \Delta\overline{HS}_{it} + \beta_3 \Delta\overline{AGE}_{it} + \beta_4 \Delta\overline{CHAGE}_{it} + \beta_5 \Delta\overline{X}_{it} + \Delta T_t + \Delta\varepsilon_{it} \quad (9)$$

where *AGE* is the child's mother's age, *CHAGE* is the child's age, and *X* is the set of control variables that vary over time: mother's household wage, education, marital status, overweight status, and obesity status and the total number of children under the age of 18 living in the home.

For $\hat{\beta}_1$and $\hat{\beta}_2$ to have causal interpretations, changes over time in work hours must be uncorrelated with changes over time in the error term, and child overweight status must not determine parent work hours. ABL's finding that the estimated effect of mother's work hours on a child's P(Overweight) using a long differences model was statistically indistinguishable from estimates obtained using instrumental variables models provides some evidence to support these assumptions. However, I cannot completely rule out the possibilities of omitted variable bias and reverse causality. Omitted variable bias may result if a lack of concern for child health both leads parents to work more and children to gain weight, or if general ambition causes parents to work more and also closely monitor their children's health habits. Differencing mitigates these concerns, as concern for children's health and ambition should be relatively stable over time. Reverse causality would result if the health problems of overweight children cause parents to work less, in which case $\hat{\beta}_1$and $\hat{\beta}_2$ would understate the true causal effects of work hours.

I also estimate several variations of this model.[16] First, I include the interaction terms $\overline{H} * \overline{UNMARRIED}$ and $\overline{H} * \overline{HS}$. Next, I conduct separate regressions for boys and girls to determine if the work hour effects differ on the basis of the child's gender. Finally, I examine whether the work hour effects are different for different age ranges. I estimate (9) differencing between the child's last observation before turning 12 and her first observation after turning 3. I then estimate (9) differencing between the child's last observation before turning 18 and her first observation after turning 11.[17] I use the age ranges 3 to 11 and 11 to 17 because this allows for a direct comparison to ABL's results, as they used the range 3 to 11.

5.2 Results

I report the coefficient estimates for the work hour variables in table 8. At the bottom of the table, I use these estimates to compute mother's work hour effects if the mother is single, married with a spouse who does not work, and married with a spouse who works 40 hours per week. I also compute mother's spouse's work hour effects if the mother does not work and if the mother works 40 hours per week. Estimating the baseline model (9) reveals that 10 additional mother's work hours per week over the course of the child's life are associated with a statistically significant 1.6 percentage point increase in P(Overweight), but mother's spouse's work hours have essentially no effect. This suggests that mothers pay more attention to the eating and exercise habits of their children than fathers. The model assumes that the effect of mother's work hours is the same regardless of whether the mother is married and whether the spouse works, and also that the effect of mother's spouse's work hours is the same regardless of whether the mother works.

Table 8 – Effect of Work Hours on Children's P(Overweight)

	Baseline	Interactions
Work Hours (units of 10)	0.016 (0.008)**	0.018 (0.021)
Spouse's Work Hours (units of 10)	0.001 (0.008)	0.003 (0.011)
Unmarried*Work Hours	–	0.007 (0.021)
Work Hours*Spouse's Work Hours	–	–0.001 (0.004)
Number of Observations	7,261	7,261
R^2	0.007	0.007
Effect of 10 hours if mother is single	0.016 (0.008)**	0.025 (0.013)*
Effect of 10 hours if mother is married and spouse does not work	0.016 (0.008)**	0.018 (0.021)
Effect of 10 hours if mother is married and spouse works 40 hours	0.016 (0.008)**	0.014 (0.009)
Effect of 10 spouse hours if mother does not work	0.001 (0.008)	0.003 (0.011)
Effect of 10 spouse hours if mother works 40 hours	0.001 (0.008)	–0.001 (0.012)

Notes: *** represents statistically significant at the 1% level; ** 5% level; * 10% level. All regressions include the controls and year effects. Heteroskedasticity-robust standard errors are in parentheses. Observations are weighted using the average of the mother's NLSY sampling weights from the two periods used to create the differences.

After adding the interaction terms, the work hour effect is slightly stronger for children of unmarried mothers, and slightly weaker for children of married mothers whose spouses work. The long-run impact of a mother working an additional 10 hours per week on her child's P(Overweight) is 2.5 percentage points for single mothers, 1.8 percentage points for married mothers whose husbands do not work, and 1.4 percentage points for married mothers whose husbands work. If a mother's spouse works an additional 10 hours per week, her child's P(Overweight) rises by 0.3 percentage points if the mother works and falls by 0.1 percentage points if she does not. Both interaction terms are insignificant.

Table 9 displays the coefficients of interest for the regressions that divide the sample into girls and boys and into the two age ranges. The results are very similar for the two genders. The impact of mother's work hours on a child's P(Overweight) appears to be strongest in the early stages of development. Ten additional mother's work hours are associated with a statistically significant increase in P(Overweight) of 2.3 percentage points for children between the ages of 3 and 11, but a statistically insignificant increase of only 1 percentage point between the ages of 11 and 17. Mother's spouse's work hours have practically no effect for either age group. In their long differences regression, ABL, who only used the NLSY waves up to 1996, estimated the impact of 10 mother's work hours on the P(Overweight) of 3 to 11 year olds to be only 1.5 percentage points. The effect therefore appears to have become stronger over time.

Table 9 – Effect of Work Hours on Children's P(Overweight)

	Girls	Boys	3 to 11	11 to 17
Work Hours (units of 10)	0.016	0.015	0.023	0.010
	(0.011)	(0.012)	(0.011)**	(0.019)
Spouse's Work Hours (units of 10)	−0.0002	0.0005	0.002	0.002
	(0.011)	(0.012)	(0.012)	(0.023)
Unmarried*Work Hours	–	–	–	–
Work Hours*Spouse's Work Hours	–	–	–	–
Number of Observations	3,547	3,714	4,754	3,255
R^2	0.011	0.012	0.023	0.018

See notes for table 8.

6 Economic Significance

I next examine the economic significance of these results by attempting to answer two questions. First, what would be the effect of a ten-hour-per-week increase in all adults' work hours on the prevalence of obesity and overweight children, mortality, and medical expenditures? Second, what percentage of the increase in adult obesity and overweight children over the past half-century can be explained by observed changes in the employment patterns of men and women?

In Appendix A, I describe in detail the method used to determine the answers to these questions, and discuss possible caveats. Ultimately, I estimate that a ten-hour-per-week increase in the average adult's work hours would increase obesity by 4.1%, leading to 4,634 deaths and $4.84 billion in additional medical expenses per year. Adding ten hours to the work week for women would increase childhood overweight by 11.1 %, but a similar increase in men's work hours would only increase childhood obesity by 0.6%. As displayed in table 10, observed changes in employment patterns explain only 1.4% of the rise in adult obesity during the period 1961 to 2004 but a sizeable 10.4% of the rise in overweight children between 1968 and 2001.

Table 10 – Percentage of Increases in Adult Obesity (from 1961 to 2004) and Overweight Children (from 1968 to 2001) Resulting from Changes in Work Hours

	% of Rise in Adult Obesity Explained	% of Rise in Overweight Children Explained
Changes in Women's Work Hours	2.7%	11.3%
Changes in Men's Work Hours	-1.3%	-0.9%
Changes in All Adults' Work Hours	1.4%	10.4%

In all, then, my estimates suggest that permanent increases in adult work hours would have meaningful effects on both adult obesity and childhood overweight, but that the increase in labor force participation in the U.S. in recent decades has only been an important contributing factor to the rise in childhood overweight. The increase in labor force participation does not contribute more substantially to the rise in adult obesity partly because the increase in obesity from women working more is partially offset by a decrease in obesity from men working less. In contrast, the drop in men's work hours does not offset a significant portion of the effect on children because, as shown in table 8, men's work hours do not influence childhood overweight.

7 Conclusion

In this paper, I use panel data from the NLSY and NLSYCS to analyze the effects of adult work hours on adult BMI and obesity as well as childhood overweight. I find that additional work hours are associated with increases in one's own BMI and probability of being obese in all specifications. Some evidence suggests that the effects are strongest for those who are married, work at white collar jobs, and were already overweight at the beginning of the panel. Working more also raises one's spouse's BMI and P(Obese) in most specifications, but the effects are

smaller and statistically insignificant. I also find that an increase in mother's, but not mother's spouse's, work hours is associated with a higher probability that a child is overweight.

In the past half-century, female employment in the U.S. has risen while male employment has fallen by a lesser amount. I estimate that these changing employment patters account for only 1.4% of the rise in adult obesity between 1961 and 2004 but a more substantial 10.4% of the increase in overweight children from 1968 to 2001.

Looking forward, my results imply that a permanent 10 hour per week increase in the work week would eventually have meaningful effects on both adult obesity and childhood overweight, as it would increase the former by 4.1 % and the latter by 11.1 %. Anecdotal evidence suggests that many Americans are working longer hours than ever, and that employees in some professions routinely work sixty to eighty hours per week or more. Such long work weeks could have a detrimental effect on health by increasing the obesity rate.

The results of this study should not be interpreted to mean that the increase in women's labor force participation has harmed society, or that women today should reduce their work hours. The expansion of women's rights that contributed to this rise in female employment was obviously one of the great advancements of the 20th Century. My findings instead indicate that people who work long hours should realize the potential health consequences and take steps to prevent them from occurring.

Appendix A — Economic Significance Calculations

A.1 Adults

In this section, I assess the economic significance of my results by estimating the impact of a ten-hour-per-week-per-adult increase in work hours on adult obesity, as well as the percentage of the recent rise in adult obesity that can be explained by changing employment patterns.

Since the results from splitting the sample into women and men were inconclusive, in this section I assume that the work hour effect and spouse work hour effect are the same for both genders. Additionally, since I was unable to reach a definitive conclusion about whether or not the work hour effect is different for singles and married people, I assume that the work hour effect does not depend on marital status. Finally, since I found that the work hour effect was similar for married people whose spouses work and those whose spouses do not work, I assume the same effect for the two groups. Therefore, I calibrate the equations in this section using the results from the first column in the right half of table 3, in which I estimated that ten work hours per week increases P(Obese) by 0.013 percentage points, and that ten spouse work hours increases P(Obese) by 0.0006 percentage points.

The overall effect of an increase in women's work hours on obesity is equal to its effect on women plus its effect on men. The derivative of the obesity rate with respect to women's work hours is therefore:

$$\frac{dO}{dH_W} = P_W\frac{dO}{dH} + P_M M_M\frac{dO}{dHS} \tag{10}$$

where O is the obesity rate, H_W is the average hours worked per week for women, P_W is the proportion of the adult population that is female, P_M is the proportion of the adult population that is male, M_M is the proportion of adult men who are married, and dO/dH and dO/dHS are the derivatives of the obesity rate with respect to own work hours and spouse's work hours. Similarly, the change in obesity with respect to a change in men's work hours is:

$$\frac{dO}{dH_M} = P_M\frac{do}{dH} + P_W M_W\frac{dO}{dHS} \tag{11}$$

(10) and (11) reduce to:

$$\frac{dO}{dH} = \frac{do}{dH} + M\frac{dO}{dHS} \tag{12}$$

where H is average hours worked by all adults and M is the proportion of the adult population that is married. After calibrating (12) using the estimates from this paper along with the marriage rate from the 2000 census, it becomes:

$$\frac{dO}{dH} = 0.013 + 0.54(0.0006) = 0.013324$$

Dividing this result by the 2004 obesity rate of 0.322 shows that a ten-hourper-week increase in the average adult's weekly hours worked would increase the obesity rate by approximately 4.1 %. Using the estimated costs of obesity from the introduction, these numbers translate to 4,634 deaths and $4.84 billion in medical expenditures per year.

I next estimate the percentage of the increases in adult obesity (from 1961- 2004) that can be explained by changes in work hours during the periods.[18] The proportion of adults who are obese because of women's work hours (O_{HW}) in period t is simply dO/dH_W multiplied by the average hours worked by women in t:

$$O_{HWt} = H_{Wt}\frac{dO}{dH_W} \tag{13}$$

I approximate average weekly work hours for adult women using the percentage of single and married women employed part- and full-time combined with the average work hours for part- and full-time workers:

$$H_{Wt} = W_{St}\,(SW_{Ft}H_F + SW_{Pt}H_P) + W_{Mt}\,(MW_{Ft}H_F + MW_{Pt}H_P) \tag{14}$$

where t is 1961 or 2004, W_S is the proportion of women who are single, SW_F is the proportion of single women who are employed full time, H_F is the average weekly work hours (in units of 10) for full-time employees, SW_P is the proportion of single women who are employed part time, H_P is the average weekly work hours for part-time employees, and married (M) replaces single in the second half of the expression. Combining (10), (13), and (14), I obtain:

$$O_{HWt} = [W_{St}\,(SW_{Ft}H_F + SW_{Pt}H_P) + W_{Mt}\,(MW_{Ft}H_F + MW_{Pt}H_P)] * \left[P_W\frac{dO}{dH} + P_M M_M\frac{dO}{dHS}\right] \tag{15}$$

The equation for men is analogous. Calibrating the parameters using data from the Current Population Survey yields the following set of equations:[19]

$O_{HW,1961}$ = [(0.34)(0.34*4.48+0.11*2.15)+0.66(0.23*4.48 +0.08*2.15)] [0.53 *0.013+0.47*0.69*0.0006] = 0.010

$O_{HM,\,1961}$ = [(0.31)(0.49*4.48+0.04*2.15)+0.69(0.83*4.48 +0.07*2.15)] [0.47*0.013+0.53 *0.66*0.0006] = 0.021

$O_{HW,2004}$ = [(0.49)(0.40*4.48+0.14*2.15)+0.51(0.43*4.48 +0. 15*2.15)][0.52*0.013+0.48*0.56*0.0006] = 0.015

$O_{HM,2004}$ = [(0.44)(0.55*4.48+0.07*2.15)+0.56(0.67*4.48 +0.08*2.15)][0.48*0.013+0.52*0.51 *0.0006] = 0.019

Between 1960 and 2004, the adult obesity rate rose by 19.4 percentage points. The percentages of this rise explained by changes in female and male employment patterns are:

$$\frac{O_{HW,2004} - O_{HW,1961}}{0.194} * 100\% = 2.7\% \text{ and}$$

$$\frac{O_{HW,2004} - O_{HW,1961}}{0.194} * 100\% = -1.3\%$$

Therefore, the rise in female employment accounted for 2.7% in the rise in adult obesity between 1961 and 2004, while the concurrent drop in male employment offset almost half of this increase. In total, changes in work hours accounted for 1.4% of the rise in obesity during the period.

A.2 Children

I next conduct a similar analysis for children. Given the lack of conclusive results when adding the interaction terms and splitting the sample into girls and boys, in this section I assume that the work hour effect is the same for girls and boys, as well as children of single and married mothers and children of married mothers whose husbands work and married mothers whose husbands do not work. Therefore, I calibrate the equations in this section using the results from the first column of table 6. The effect of a mother working ten hours per week on her children's P(Overweight) is 0.016, while the effect for the mother's spouse is 0.001.

The following equation expresses the change in the percentage of children who are overweight if women's work hours increase by ten per week:

$$\frac{dO_C}{dH_W} = P_{CW}\,\frac{dO_C}{dH} \tag{16}$$

where O_C is the proportion of children who are overweight, P_{CW} is the proportion of children who live with their mothers (or another female guardian), and $dO_C/dHWK$ is the change in the "overweight rate" of children who live with their mothers with respect to a change in women's work hours. The effect of a change in men's work hours is, similarly:

$$\frac{dO_C}{dH_M} = P_{CM}\,\frac{dO_C}{dHS} \tag{17}$$

where $dO_C/dHSP$ is the mother's spouse work hour effect. Calibrating (16) and (17), again using data from the 2000 census, yields:

$$\frac{dO_C}{dH_W} = 0.95(0.016) = 0.015 \text{ and } \frac{dO_C}{dH_M} = 0.76(0.001) = 0.00008$$

Dividing by the 0.135 rate of overweight children, I find that a 10 hour rise in the average woman's work hours increases the prevalence of overweight children by 11.1%, while such a rise in men's hours increases it by only 0.06%.

I next estimate the percentage of the rise in overweight children from 1968- 2001 that can be explained by changes in adult work hours.[20] The proportion of children who are overweight because of maternal employment (O_{CHW}) in period t is:

$$O_{CHWt} = H_{WCt}\,\frac{dO_C}{dH_W} \tag{18}$$

where HWK_{WC} is the average weekly hours worked by women who live with children.

$$H_{WCt} = WC_{St}\,(SW_{Ft}H_F + SW_{Pt}H_P) + WC_{Mt}\,(MW_{Ft}H_F + MW_{Pt}H_P) \tag{19}$$

where WC_S is the proportion of women with children who are single and WCM is the proportion who are married. Combining (16), (18), and (19) yields:

$$O_{CHWt} = [WC_{St}\,(SW_{Ft}H_F + SW_{Pt}H_P) + WC_{Mt}\,(MW_{Ft}H_F + MW_{Pt}H_P)]\,P_{CW}\,\frac{dO_C}{dH} \tag{20}$$

The equation for men is analogous. I calibrate (20) using data from the Current Population Survey:

$O_{CHW,1968}$ = [0. 11(0.36* 4.48+ 0.12* 2.15)+ 0.89(0.26* 4.48+ 0.09* 2.15)] *0.99 * 0.016
= 0.022

$O_{CHM,1968}$ = [0.01(0.48* 4.48+ 0.04* 2.15)+ 0.99(0.81 *4.48+0.07*2.15)] *0.89 * 0.001
= 0.003

$O_{CHW,2001}$ = [0.26(0.41* 4.48+ 0.14* 2.15)+ 0.74(0.45* 4.48+ 0.15* 2.15)] *0.95 * 0.016
= 0.035

$O_{CHM,2001}$ = [0.26(0.41* 4.48+ 0.14* 2.15)+ 0.74(0.45* 4.48+ 0.15* 2.15)] *0.95 * 0.001
= 0.002

The proportion of children who are overweight rose by 11.5 percentage points between 1968 and 2001. The percentages of this increase that can be explained by changes in female and male employment are:

$$\frac{O_{CHW,2001} - O_{CHW,1968}}{0.115} * 100\% = 11.3\% \text{ and}$$

$$\frac{O_{CHW,2001} - O_{CHW,1968}}{0.115} * 100\% = -0.9\%$$

Table 10 summarizes the percentages of the rise in adult obesity and childhood overweight that can be attributed to changing employment patterns. Limitations in the data force me to make three potentially problematic assumptions in the calculations in this table. First, I assume that average hours worked per week for both full- and part-time workers are constant over time. Popular consensus is that the work week has lengthened; this would mean my results understate the true effect. Also, I assume that people work the same number of hours regardless of whether or not they have children. Since having children often causes one or both parents to reduce work hours, the change in mothers' work hours may be smaller than the change in women's work hours; therefore, my results for children may be exaggerated. Finally, I assume that the derivatives estimated in this paper are constant over time. People today have far greater access to fast food and other unhealthy pre-prepared food than they did forty years ago, suggesting that the work hour effect may be stronger today, and that the impact of changes in labor force participation in the 1960's and 1970's on body weight may have been smaller than my results suggest. On the other hand, it is possible that increased work hours induced demand for convenience food that, once created, was consumed by all. If this is the case, my derivatives understate the true effect of changing labor markets on obesity. Because of these limitations, the results in table 10 should be viewed as rough estimates and not exact calculations.

Notes

*Department of Economics, Bryan School of Business and Economics, University of North Carolina at Greensboro. P.O. Box 26165, Greensboro, NC 27402. E-mail: cjcourte@uncg.edu. Phone: (336)334-3910. Fax: (336)334-4089. I am grateful to Sebastian Galiani, Daifeng He, Edward Greenberg, Michael Grossman, Patrick McAlvanah, Jeremy Meiners, Charles Moul, Donald Nichols, Bruce Petersen, Michael Plotzke, Paul Rothstein, and Chris Ruhm for valuable suggestions. I also thank seminar participants at Washington University in St. Louis, as well as the editor and two anonomous referees. This research was conducted using restricted data from the Bureau of Labor Statistics. The views expressed in this paper do not reflect those of the BLS. All errors are my own.

1. Children and adolescents are classified as "overweight" if they have a BMI at or above the 95th percentile based on age- and gender-specific growth charts. With children and adolescents, the term "obese" is used interchangeably with "overweight;" I use the term overweight in this paper. Percentiles are determined using child BMI data from the second and third National Health Examination Surveys (NHES II and NHES III) and from the first, second, and third National Health and Nutrition Examination Surveys

(NHANES I, NHANES II, and NHANES III). These surveys spanned the period 1963-1994; therefore, the percentage of children who are overweight is not fixed at 5%.

2. They divided the state-level data into sixty-four groups based on year, gender, race, marital status, age, and education, and assigned each person a predicted hours and wage that corresponded to his/her group.
3. I drop women who are pregnant in either of the two years used to compute the differences.
4. Since the NLSY generally interviewed mothers and their children at the same time, virtually all children in the NLSYCS lived with their mothers. Therefore, modeling their weight as a function of their mother's attributes should be reasonable.
5. Self-reported weight and height could be problematic as people commonly underreport their weight and, to a lesser extent, overreport their height. However, researchers with access to both self-reported and actual weight and height have shown that, in regressions of body weight, correcting for errors in the self-reported values does not substantially alter coef~cient estimates (i.e. Cawley, 1999; Lakdawalla and Philipson, 2002). In other words, the extent to which one underreports weight or overreports height does not appear to be correlated with the variables commonly included in body weight regressions.
6. I construct hourly rate of pay for the household by dividing total household income by the sum of own and spouse's work hours (which are zero if the person is single). I set rate of pay to zero for households where neither the respondent nor her spouse worked at all during the preceding year; this affects a very small percentage of households.
7. See Culter et al(2003) for a model that depicts this phenomenon.
8. I use age 23 instead of 18 because individuals in the 18-22 age group are likely to be college students. Students may work a large number of hours, but the NLSY work hour statistics do not reflect unpaid work, such as studying.
9. In regressions not reported in this paper, I difference between the last and first years and obtain very similar results.
10. Results are robust to starting at a different age.
11. I estimate linear probability models (LPMs) when change in obesity status is the dependent variable. In the children's section, this makes my results comparable to those of ABL, who also used LPMs. All results are robust to the use of ordered probit and multinomial logit models.
12. I cannot completely rule out the possibility that my estimates are biased upward. For example, people who work long hours may be those who are less concerned about their health than others and therefore weigh more.
13. An extensive literature examines the relationship between obesity and wages, generally finding that being obese is associated with reduced wages, at least for women. For an example, see Cawley (2004).
14. NLSY surveys were not conducted in 1995, 1997, 1999, 2001, or 2003. The values of the independent variables in year $t-1$ are therefore not defined in 1996, 1998, 2000, 2002, and 2004, while the values in year $t-3$ are not defined in 1998, 2000, 2002, and 2004. In these cases, I set the average over the current year and last year equal to simply the current year's value, and I set the average over two and three years ago equal to simply the value two years ago.
15. The coefficient estimates for the control variables, available upon request, are generally consistent with previous research.
16. I do not report estimates from a model including three averages of the independent variables because this approach causes most of the sample to be dropped. Creating the three averages requires a minimum of four lags in the initial period of the long differences models. However, most children are three years old in the initial period, in which case fewer than four lags are available.
17. When using the 3 to 11 age range, I drop the child if she does not have an observation after age 9 in order to ensure a reasonably long difference between the initial and final periods. When using the 11 to 17 age range, I drop the child if she is not observed by age 13.
18. The initial period was actually 1960-62, so I use the midpoint.
19. 1960 marriage rates are taken from the 1960 census.
20. The initial period was 1963-1970, so I use the midpoint of that range.

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