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The connection between working hours and body mass index in the U.S.: a time use analysis

Joelle Abramowitz

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Abstract Over recent decades, Americans have transitioned from working in active jobs to working in sedentary jobs, and there have been dramatic increases in hours worked for certain demographic groups. While a body of research documents that time spent working is associated with increased body mass index (BMI), this paper explores possible mechanisms for that relationship using time use data. This paper finds that, for workers in non-strenuous jobs, 10 additional hours spent working are associated with an increase in BMI of 0.424 for women and 0.197 for men, representing an increase of 2.5 and 1.4 pounds, respectively. The paper does not find a relationship between working time and BMI for workers in strenuous jobs. For workers in non-strenuous jobs, the effect of time spent working on BMI becomes smaller after accounting for time spent sleeping for both men and women and time spent in exercise and food preparation for women only; the effect becomes larger after accounting for screen time for both men and women and time spent in secondary eating and commuting for women only. Screen time is the single time use channel associated with the largest differences in the estimated effect of time spent working on BMI for both women and men employed in non-strenuous jobs. After controlling for all time use channels, the effect of hours worked on BMI decreases for women, but increases for men. These findings suggest plausible mechanisms for the association between time spent working and obesity.

Keywords Obesity · Time use · Working hours · Body mass index · BMI · Health behaviors

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J. Abramowitz (✉)
U.S. Census Bureau, 4600 Silver Hill Road, Washington, DC 20233, USA
e-mail: joelle.h.abramowitz@census.gov

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1 Introduction

Over recent decades, the nature and duration of work has changed for many Americans. Americans have transitioned from working in active jobs to working in sedentary jobs, with the prevalence of moderate intensity physical activity occupations decreasing from 48 % in 1960 to 20 % in 2008 (Church et al. 2011). Over the same period, while average weekly market work hours per person have been roughly constant, there have been major shifts among demographic groups with, for example, dramatic increases in hours worked for women (Aguiar and Hurst 2007) and the share of employed men working more than 48 h per week (Kuhn and Lozano 2008). Further, the majority of employed men and women report working 40 h per week or more, with the distribution particularly skewed for men, as shown in Fig. 1. The full consequences of increasing work hours and changes in the nature of work are not explored in the literature. These developments could affect individuals in many ways including their weight and health.

This paper primarily examines the mechanisms through which time spent working affect an individual's weight as measured by body mass index (BMI). In general, BMI might increase with more hours spent working since as leisure time declines, the opportunity cost of time rises. As an individual works more hours, she has less leisure time available, and it thus becomes more costly to undertake health-producing activities such as exercise, food preparation, and sleep, as well as to seek medical care. On the other hand, time spent working could be associated with a lower BMI if individuals use increased income to substitute away from time-intensive health investments to goods-intensive health investments. An increase in time spent working in non-strenuous jobs could affect BMI in particular if individuals who were previously active during their working hours are now sedentary at work and do not proportionately increase activity in their non-work time.

Examining the relationship between working time and obesity, Fig. 2 shows the proportion overweight by weekly work hours for employed individuals. Here, it appears that working longer hours is associated with a higher likelihood of being overweight. Since it is important to control for other factors that might affect this relationship, more in-depth analysis of this question is valuable.

A number of papers have considered the effect of the business cycle on health. Many papers examine the relationship between employment and unemployment indicators and health outcomes and behaviors (Ruhm 2000, 2003, 2005, 2007; Bockerman et al. 2007; Charles and DeCicca 2008; Arkes 2009; Dave and Kelly 2012). In addition, several papers have examined the effect of the business cycle on health-related time use channels (Burda and Hamermesh 2010; Aguiar et al. 2013; Colman and Dave 2013a; Deb et al. 2011). While these papers are informative with regard to the effects of the business cycle on health behaviors and health outcomes, they do not directly measure the effects of working time, the topic of interest of this analysis.

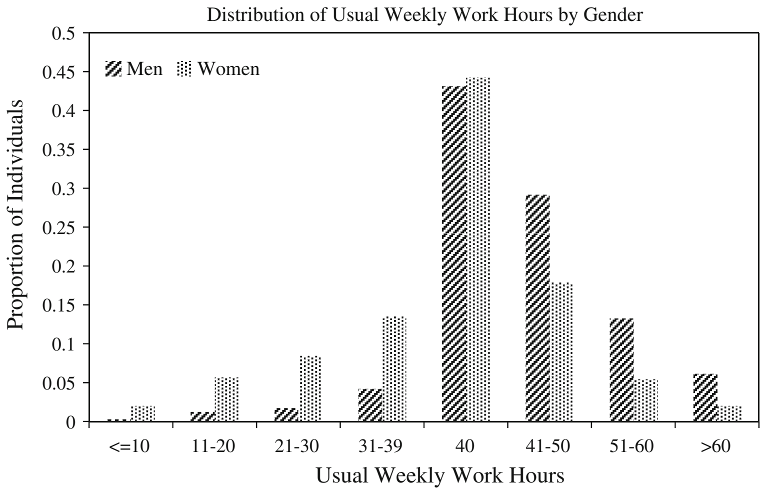

Fig. 1 The figure shows the distribution of usual weekly work hours by sex in the 2006–2008 ATUS. As can be seen in the figure, the majority of both men and women report working 40 h per week or more, with the distribution particularly skewed for men. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

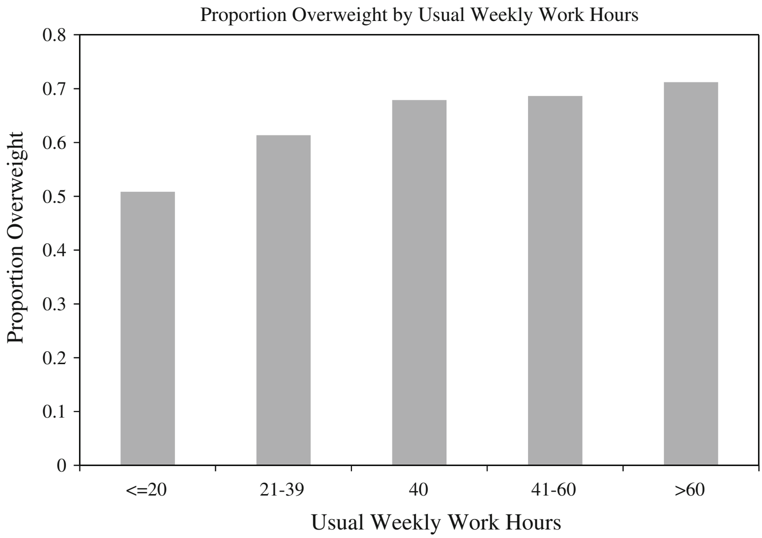

Fig. 2 The figure shows the proportion overweight by weekly work hours. Working longer hours appears to be associated with a higher likelihood of being overweight. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

Several papers specifically examine the connection between time spent working and health outcomes. Courtemanche (2009) uses long differencing methods and the National Longitudinal Study of Youth 1979 (NLSY) to find that longer hours increase one's own BMI and probability of being obese. Berniell (2012) uses the change in the legal maximum workweek hours in France enacted in 1998 to find that a reduction of working time is associated with a drop in the probability of smoking, in alcohol consumption, and in physical inactivity. Xu (2013) examines the effects of wages and working hours on health behaviors of men aged 25–55 with some college education or less and finds that increases in hours worked are associated with an increase in cigarette smoking, a reduction in physical activity, and fewer visits to physicians. The above papers have documented the positive relationship between time spent working and BMI and some health behaviors, but the question remains as to what channels drive this relationship.

A number of papers have explored time use data to consider how individuals' time use might play a role in their health outcomes. Biddle and Hamermesh (1990) use the 1975–1976 Time Use Study to find a negative relationship between time spent working and time spent sleeping. More recently, Hamermesh (2010) finds that more time spent eating (and grazing) is associated with a lower BMI and better self-reported health. Colman and Dave (2013b) find that time spent on physical activity (including work-related physical activity) reduces risk factors for heart disease, including BMI. Kolodinsky and Goldstein (2011) find that individual time uses related to food were insignificant in predicting the probability of being overweight, but that once an individual crosses the overweight threshold, these time uses are significant in predicting BMI. Zick et al. (2011) investigate the relationship between BMI and various uses of time including physical activity time, television/video viewing time, sleep time, primary eating time, secondary eating time, and food preparation time. In addition, several papers examine the mechanisms through which parents' working time affects time spent with children as well as children's health outcomes. Fertig et al. (2009) use the Child Development Supplement from the Panel Study of Income Dynamics to investigate the channels through which maternal employment affects childhood obesity. Cawley and Liu (2012) use ordinary least squares models and the ATUS to investigate the mechanisms through which maternal employment might be associated with childhood obesity. Anderson (2012) uses Early Childhood Longitudinal Survey-Kindergarten Class of 1998–1999 (ECLS-K) data to investigate the relationships among maternal employment, family routines, and obesity. While all of these papers consider different aspects through which individuals' time use can affect health outcomes, none specifically addresses the relationship between own working time, own time in health-related activities, and own BMI.

This paper contributes to the literature in several ways. First, while other papers have examined the effect of the business cycle on health behaviors and outcomes, this paper specifically considers the difference in outcome for a worker's marginal hour of work by examining workers' time spent on the job. Further, building on the literature finding a relationship between working time and BMI, this paper investigates the potential eating, health investment, and physical activity channels driving this relationship to obtain a fuller picture of how work time affects lifestyle choices that affect weight and health.

This analysis uses the 2006, 2007, and 2008 American Time Use Survey (ATUS) linked with Eating and Health module interviews and the Compendium of Physical

Activities. While other datasets provide information on individuals' market work time, the ATUS also provides insight into individuals' non-market work activities. Linked with the Eating and Health module, it permits inference to be drawn about individuals' time use in a variety of activities as well as measures relating to eating and health, including BMI. The linked ATUS and Eating and Health module data provide great insight into the relationship between time use and weight and health and can be very valuable in understanding the relationship between working time and BMI and health.

This analysis aims to identify channels through which time spent working could affect BMI.[1] To address this question, I first reproduce the result found in other papers that increased working time is associated with a positive and significant effect on own BMI for both men and women using the ATUS. Next, I estimate a series of equations including controls for time spent in each of a variety of activities associated with eating, health investment, and physical activity to investigate the channels through which working time may impact BMI. This approach treats time spent in each activity as an omitted variable and tests whether its inclusion results in a significant difference in the effect of time spent working on own BMI. Because the relationships between one's own time spent working, one's own time in health-related activities, and one's own BMI may be due not only to a direct causal link, but also to some unobservable characteristics which result in these correlations or to reverse causation, findings from this approach must be interpreted as highly suggestive and not necessarily causal.

Results suggest plausible mechanisms for the association between time spent working and obesity. As a baseline, I find that for workers in non-strenuous jobs, 10 additional hours spent working are associated with an increase in BMI of 0.424 for women and 0.197 for men, representing an increase of 2.5 pounds and 1.4 pounds, respectively. A number of the tested channels appear to impact the effect of hours worked on BMI. For workers in non-strenuous jobs, the effect of time spent working on BMI becomes smaller after accounting for time spent sleeping for both men and women and time spent in exercise and food preparation for women only. However, the effect of time spent working on BMI becomes larger after accounting for screen time for both men and women and time spent in secondary eating and commuting for women only. Screen time is the single time use channel associated with the largest differences in the estimated effect of time spent working on BMI was screen time for both women and men employed in non-strenuous jobs. No effects were found for any channels for women working in strenuous jobs, and effects for men working in strenuous jobs were similar to those found for men working in non-strenuous jobs.

The rest of the paper is organized as follows. The next section presents a theoretical framework for understanding the channels through which time spent working could affect time spent in health-related activities and BMI. The sections that follow present the data used in the analysis, outline the empirical specifications, and show results of the analysis. The last section concludes.

[1] This analysis focuses on the intensive margin (hours of work) and not the extensive margin (labor force participation).

2 Theoretical framework

Given the amount of time individuals spend working, it is important to consider the effects of work on health and the channels driving these effects. To formally outline these channels, the theoretical framework used in this paper follows the model presented in Xu (2013) based on Grossman (1972, 2000). An individual maximizes his utility subject to time and budget constraints and utility depends on current health status. Health is generated according to a health production function reflecting investment in health-related commodities, time spent working, environmental factors, and genetic endowment. A change in hours worked could have several effects on health. The income effect of increased working time would be positively associated with the consumption of goods including health-related commodities and would thus lead to increased health. The substitution effect of increased working time would be negatively associated with time spent in other consumption including health-related commodities and would lead to decreased health. Since each of these effects act in opposite directions, the net effect would be ambiguous, but is likely to be positively (negatively) associated with consumption of goods that are relatively less (more) time-intensive.

As outlined in Courtemanche (2009), there are several mechanisms through which work hours could affect weight and health. If an individual works more hours, her leisure time drops, which could increase her weight through four mechanisms. First, she might exercise less and spend less time in active pursuits, decreasing calories expended and leading to weight gain. Second, she might devote less time to food preparation and eating during meals, causing a substitution from home-prepared meals to snacking and eating unhealthy convenience food, such as fast food and prepared processed food. This substitution could increase caloric intake, as a body of research links a higher frequency of eating fast food to greater consumption of calories, fat, and saturated fat and also to obesity (Satia et al. 2004; Jefferey et al. 2006; Chou et al. 2004). 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 (Gangwisch et al. 2005; Taheri et al. 2004). Fourth, she may devote less time to health-promoting activities such as seeking medical care and engaging in non-market work and activities.

Other papers have empirically documented a positive relationship between working hours and BMI. This paper will proceed by testing potential channels driving this relationship. The paper next presents the data used in the analysis, replicates other papers' findings for the relationship between working time and BMI, and presents the empirical strategy for investigating the question of this analysis.

3 Data

The analysis uses the 2006, 2007, and 2008 ATUS linked with Eating and Health module interviews data and the Compendium of Physical Activities. While other datasets provide information on individuals' market work time, the ATUS also provides insight into individuals' non-market work activities. Linked with Eating and Health module interviews, it permits inference to be drawn about individuals' time use in a variety of activities as well as measures relating to eating and health, including BMI. The ATUS collects detailed information on how respondents spend their time over a 24-h period and provides valid, reliable measures of time spent in various activities. Each ATUS respondent is randomly selected from the members ages 15 and older of households that completed their final interview for the Current Population Survey in the preceding 2–5 months. In 2006, 2007, and 2008, the ATUS respondents were also asked a series of questions known as the Eating and Health module. The Eating and Health module interviews asked respondents about their time spent eating and drinking as well as their height and weight and self-reported health status. The linked ATUS and Eating and Health module data provides great insight into the relationship between time use and weight and health and can be very valuable in understanding the relationship between working time and BMI and health.

In order to identify the degree of strenuousness of work engaged in by each respondent, the analysis follows Tudor-Locke et al. (2009) who have linked the ATUS time use lexicon to the Compendium of Physical Activities. Following Zick et al. (2011), to consider occupational physical activity requirements in the analysis, a respondent who works in an occupational category designated with a metabolic equivalent of task (MET) value of 3.3 or more is considered to work in a strenuous occupation.[2]

The analysis includes only employed individuals. Individuals enrolled in school are excluded from the analysis since it is unclear whether time spent in schooling should be considered work or leisure. The sample was limited to individuals ages 25–64 since they are likely to be living on their own and have completed their schooling.[3] In addition, individuals who reported being pregnant were excluded from the analysis since their reported BMI might be uncharacteristic of the general population. The full sample includes 13,544 individuals. Summary statistics for the sample are presented in Table 1.[4]

The summary statistics show that the mean age in the sample is 43 years, 53 % are men, 70 % are married or living with a partner, 46 % have children under the age of 18, 20 % have children under the age of 6, and 71 % are white. The average weekly income is $907 and the average usual weekly work hours is 43. The mean BMI for the sample is 28, with a BMI of between 25 and 30 being classified as overweight. 67 and 29 % of the sample are classified as overweight and obese, respectively. The majority report at least very good health. The majority have at least some college education.

[2] Following Zick et al. (2011), a MET value $\geq$3.3 is used as a cut-off as this captures occupations such as building and grounds cleaning and maintenance, farming, and construction and extraction.

[3] This follows the methodology in Zick et al. (2011).

[4] Individuals with missing data are excluded from the analysis.

Table 1 Summary statistics

Variable	Mean	Standard deviation
Age	42.87	10.51
Proportion men	0.53	0.50
Proportion married/cohabiting	0.70	0.46
Children aged <18 in household	0.46	0.50
Children aged <6 in household	0.20	0.40
Proportion less than high school diploma	0.08	0.28
Proportion high school graduates	0.29	0.45
Proportion some college	0.26	0.44
Proportion college graduates	0.36	0.48
proportion white	0.71	0.46
Proportion black	0.10	0.30
Proportion Hispanic	0.13	0.34
Proportion other race	0.06	0.23
Own weekly income	907.08	619.52
BMI	27.67	5.51
Proportion overweight	0.67	0.47
Proportion obese	0.29	0.45
Proportion reported excellent health	0.21	0.41
Proportion reported very good health	0.39	0.49
Proportion reported good health	0.31	0.46
Proportion reported fair health	0.08	0.28
Proportion reported poor health	0.01	0.09
Usual weekly work hours	42.51	11.26
Proportion with strenuous jobs	0.10	0.29
Proportion with a spouse working full-time	0.55	0.50
Observations	13,544	

Descriptive statistics are calculated using ATUS population-representative weights. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

4 Methods

4.1 Empirical strategy

The goal of this analysis is to investigate the channels that may be driving the positive relationship between time spent working and BMI. To perform this analysis, I first estimate a baseline ordinary least squares specification to measure the relationship between time spent working and own BMI that does not include any possible time use channels, only control variables for individual characteristics. Next, I re-estimate the specification including controls for time in minutes spent in one of the potential channels.

The baseline estimation follows the specification:

$$y_i = \alpha_0 + \alpha_1 \text{ WorkingTime}_i + \alpha_2 X_i + \varepsilon_i$$

where y_i represents BMI, measured continuously.[5] Working time (α_1) measures the usual hours spent in work each week in 10-h increments.[6,7,8] In addition to controlling for hours worked, I also include a control for strenuous work and an interaction term for strenuous work and hours worked in order to capture effects separately for workers in strenuous jobs and those in non-strenuous jobs.[9] This allows for estimating the effect of working hours for workers in non-strenuous jobs and the effect of working hours for workers in strenuous jobs from each regression. For workers in non-strenuous jobs, the coefficient on working time captures this effect. For workers in strenuous jobs, the effect is captured by the linear combination of the coefficients on working time and its interaction with the coefficient on strenuous work. I construct control variables for individual characteristics, X, similar to those used in Courtemanche (2009). The control variables include: spouse working full-time, age, age squared, race, sex, marital status,[10] own weekly income,[11] occupation, education, poor health, whether there are children younger than 18 living in the household, whether there are children younger than 6 living in the household, state, metropolitan status, season, an interaction for the winter season and the Northeast and Midwest regions, and year. The specifications is estimated separately for men and women, the data is weighted to be population-representative, and robust standard errors are used.

The analysis posits that time spent working affects time spent in health-related activities, thereby affecting one's own BMI. To investigate this question, I next examine whether the inclusion of controls for a variety of health-related time use channels significantly change the estimated effect of time spent working on BMI.

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5 Specifications with overweight status and obesity status as the dependent variables, each measured as dummy variables equal to 1 if the individual is classified as being overweight (BMI $\geq$25) or obese (BMI $\geq$30), respectively, and equal to 0 otherwise were also estimated, and the results were qualitatively similar.

6 While data on actual hours worked on the diary day is available, these are not representative for many individuals in the sample since half of diary days are weekend days. Limiting the sample to only individuals with positive hours worked on the diary day could still not be representative of an individual's usual work hours and reduces the sample greatly. Therefore, usual weekly work hours was used as the measure of time spent working.

7 BMI is a stock measure, which is a function of cumulative excess caloric intake. The most appropriate measure of work time is then also a stock measure such as cumulative hours worked on the job or job tenure. However, since this information is not necessarily accurate or available in a consistent manner, current usual weekly work hours are used.

8 Using log usual hours worked yielded qualitatively similar results.

9 The majority of the sample consists of workers in non-strenuous jobs: 4 % of women (238) and 12 % of men (837) worked in strenuous jobs. Results for the effect of non-strenuous work hours were nearly identical to the estimated effect of hours worked from specifications including only workers in non-strenuous jobs.

10 Marital status controls for whether the individual was living with a spouse or partner at the time of the CPS interview.

11 Specifications including categorical controls for household annual income rather than own weekly income and specifications excluding the income control yielded qualitatively similar results.

The potential channels I examine include time spent in activities associated with eating, health investment, and physical activity.[12] These activities, including summary statistics for minutes spent in various activities by individuals in the analysis sample, are presented in Table 2.

Time spent in primary eating includes time spent where eating and drinking was the central activity being performed. Time spent in secondary eating and secondary drinking includes time spent where eating and drinking were performed while primarily performing another activity. Time spent in primary eating, secondary eating, secondary drinking, food preparation, grocery shopping, and purchasing prepared food are examined because the more hours a person works, the less time she might have for devoting time to meals and meal preparation, but the more time she might eat or drink less healthy prepared foods while in engaged in other activities, which could lead to increased food consumption and weight gain.[13] Time spent in sleeping, exercise, housework, screen time, and commuting are examined because they involve energy expenditure in non-work activities and are used to capture how time spent working impacts the use of non-work time in physically demanding or sedentary activities.[14,15] If individuals substitute work time for sedentary activities, increased work time could be associated with a lower BMI; if individuals substitute work time for physically demanding activities, increased work time could be associated with a higher BMI. Medical care time is examined as a measure of health investment since if individuals spend more time at work they might have less time to devote to medical care.

To identify whether any of these potential channels are associated with differences in the effect of working time on BMI, I follow the specification in Fertig et al. (2009). I estimate a regression equation for each of the potential channels where each additional equation consists of the baseline specification as well as a control for time in minutes spent in one of the potential channels. For example, here, a control for minutes spent in primary eating is added to the specification:

$$y_i = \beta_0 + \beta_1 \mathrm{WorkingTime}_i + \beta_2 \mathrm{PrimaryEating}_i + \beta_3 X_i + \mu_i$$

where ε and μ are idiosyncratic error terms with mean zero. I then test whether the coefficients on time spent working from the baseline estimation and each specification are equal ($\alpha_1 = \beta_1$) and report the difference ($\alpha_1 - \beta_1$) and corresponding robust standard errors. This approach treats the potential channels as omitted variables and tests whether the inclusion of the channel results in a significant difference in the effect of time spent working on own BMI. The interpretation of this estimate follows that of an omitted variable such that:

[12] An alternative analysis could use time spent in the activity multiplied by the MET value associated with the activity to use a measure of activity duration and intensity as in Saffer et al. (2013) and Colman and Dave (2013a). This is discussed further in Sect. 7.

[13] Satia et al. (2004), Jefferey et al. (2006), and Chou et al. (2004) link a higher frequency of eating fast food to greater consumption of calories, fat, and saturated fat and also to obesity.

[14] Colman and Dave (2013b) show that increased physical activity is associated with a lower BMI.

[15] Gangwisch et al. (2005) and Taheri et al. (2004) suggest that sleep deprivation is associated with weight gain.

Table 2 Allocation of time in health-related activities

	Women			Men		
	Percent of sample reporting any time on activity	# minutes spent on activity if > 0	Unconditional # minutes spent	Percent of sample reporting any time on activity	# minutes spent on activity if > 0	Unconditional # minutes spent
Primary eating	95.5	66.0	62.9	96.2	70.4	68.1
Secondary eating	60.6	39.8	24.3	53.2	46.1	23.7
Secondary drinking	43.3	194.0	84.3	37.8	184.3	67.8
Food preparation	67.3	57.5	38.1	43.7	43.3	17.9
Grocery shopping	19.6	65.5	11.5	12.2	62.7	6.2
Purchasing prepared food	14.0	10.5	1.4	13.0	9.5	1.2
Sleeping	100.0	494.9	494.8	99.9	486.5	485.7
Exercise	14.6	71.6	10.9	17.9	103.5	17.4
Housework	86.3	144.4	120.8	73.4	129.5	89.7
Screen time	77.5	152.9	117.9	82.5	181.5	150.0
Commuting	47.6	110.1	23.4	52.0	107.2	32.4
Own medical care	5.4	38.7	7.5	3.0	50.3	3.7

Time use statistics are calculated using ATUS population-representative weights. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

$$\alpha_1 \approx \beta_1 + \beta_2\rho$$

where ρ represents the correlation between time spent working and the potential channel. A positive (negative) difference between the coefficients ($\alpha_1 - \beta_1$) indicates that $\beta_2\rho > 0$ (<0), suggesting that the effect of the potential channel on own BMI and the correlation between time spent working and the potential channel are the same (opposite) sign. Thus, if the sign of the correlation between time spent working and the potential channel is assumed, the sign of the effect of the potential channel on own BMI can be inferred.

4.2 Interpretation of estimated effects

The estimated effects of the time spent in eating, health, and physical activity cannot be interpreted as the causal effects of time spent working. The decision of how much time to work is endogenous and may be determined by unobserved factors that directly affect time spent in eating, health investment, and physical activity.[16] In particular, the problem of reverse causation, that a person may not be able to work long hours due to being overweight and related health effects, is of concern. I attempted to address this endogeneity by instrumenting for hours worked using state-level unemployment rates, but I did not find this instrument to be both powerful and valid. While previous studies have used unemployment rates to instrument for working status or working time (Anderson et al. 2003; Cawley and Liu 2007; Xu 2013), I share the concerns of Cawley and Liu (2012) that while unemployment rates might affect working time, they might also affect BMI and health through other channels. In addition, evaluating the relationship between one's own time spent working, one's own time in health-related activities, and one's own BMI ignores possible offsetting effects from spouses or other household members. Since data on spouses is not available in the ATUS, this cannot be tested directly, although differential effects for single and partnered individuals would be interesting to examine in future analysis.

The contribution of this paper is that it documents the correlation between one's own time spent working, one's own time in health-related activities, and one's own BMI. These speculative mechanisms by which time spent working may influence BMI are then offered as hypotheses to be tested in the future by researchers with access to richer data within the household.

5 Results

5.1 Baseline results

Table 3 presents, separately for women and men, coefficient results for the baseline effects of working time on BMI. I find that additional time spent working is

[16] For example, individuals with high levels of unobserved human capital may work longer hours and may also allocate their non-working time differently. In addition, based on unobserved characteristics, individuals may have selected into initial occupations which may influence their current BMI outcomes and health behaviors: Kelly et al. (2014) find that blue-collar work early in life is associated with an increased probability of obesity and decreased physical activity later in life.

Table 3 Results for effect of working hours on BMI and health status

	BMI		Very good or excellent health status	
	Women	Men	Women	Men
Weekly hours worked (10 h)	0.424***	0.197**	−0.002	−0.001
	(0.095)	(0.087)	(0.008)	(0.008)
Strenuous work	0.237	0.839	0.015	−0.165*
	(1.419)	(1.238)	(0.123)	(0.100)
Strenuous work × weekly hours worked (10 h)	−0.208	−0.263	−0.025	0.022
	(0.390)	(0.253)	(0.033)	(0.021)
Spouse works full-time	0.076	−0.235	−0.036	−0.014
	(0.287)	(0.186)	(0.025)	(0.018)
Age	0.120	0.202***	−0.002	−0.002
	(0.082)	(0.075)	(0.007)	(0.007)
Age squared/10	−0.008	−0.022**	0.000	0.000
	(0.009)	(0.009)	(0.001)	(0.001)
Black	2.713***	0.228	−0.146***	−0.021
	(0.311)	(0.286)	(0.025)	(0.028)
Hispanic	1.008***	0.386	−0.208***	−0.138***
	(0.329)	(0.255)	(0.027)	(0.025)
Other race	−1.010***	−0.891**	−0.191***	−0.128***
	(0.363)	(0.405)	(0.039)	(0.037)
High school graduate	−0.279	0.358	0.053	0.031
	(0.454)	(0.314)	(0.038)	(0.032)
Some college	−0.758	0.564*	0.147***	0.074**
	(0.461)	(0.328)	(0.038)	(0.034)
College graduate	−2.312***	−0.670*	0.242***	0.170***
	(0.476)	(0.348)	(0.040)	(0.036)
Married	−0.573*	0.512**	0.018	−0.014
	(0.303)	(0.236)	(0.025)	(0.023)
Non-metropolitan	0.088	0.221	−0.011	−0.017
	(0.292)	(0.260)	(0.023)	(0.023)
Children < age 18 in household	−0.040	−0.123	0.032*	0.004
	(0.224)	(0.215)	(0.019)	(0.021)
Children < age 6 in household	0.513**	−0.220	−0.019	−0.026
	(0.255)	(0.208)	(0.021)	(0.021)
Poor health	2.848**	1.052		
	(1.280)	(1.266)		
Observations	6,706	6,838	6,706	6,838

Coefficients estimated from the specifications of determinants of BMI and determinants of very good or excellent health status separately for men and women. Each column presents results from a single regression. Regressions are weighted, with robust standard errors in parentheses. Specifications include state and year fixed effects as well as the individual demographic controls outlined in the Methods section with the exception of poor health status for the health status regressions. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

associated with a significantly higher BMI for both men and women working in non-strenuous jobs, but not for workers in strenuous jobs. For women working in non-strenuous jobs, α_1, the change in BMI from 10 additional hours spent working, is estimated to be 0.424. For men working in non-strenuous jobs, α_1 is estimated to be 0.197. For a woman with average height and average BMI, each additional 10 h spent working in a non-strenuous job would be associated with an increase of 2.5 pounds, and for a man with average height and average BMI, each additional 10 h spent working in a non-strenuous job would be associated with an increase of 1.4 pounds.[17] These results are consistent with other work (Courtemanche 2009; Berniell 2012) finding that increased working time is associated with a higher BMI.

5.2 Time use channels results

Table 4 presents, separately for women and men, the coefficients on working time from the baseline regressions and the difference in those coefficient estimates after including each potential channel. The first row in Table 4 presents α_1 from the baseline regression representing the effect of work hours on BMI controlling only for individual characteristics for non-strenuous and for strenuous workers. The rest of the table reports the difference between α_1 and β_1 for each of the potential time use channels separately for workers in non-strenuous jobs and for workers in strenuous jobs.

For workers in non-strenuous jobs, a number of the tested channels appear to impact the effect of hours worked on BMI showing significant differences in the estimate of effect of hours worked. The single time use channel associated with the largest differences in the estimated effect of time spent working on BMI was screen time for both women (−0.042) and men (−0.034). Accounting for time spent on screen time, the effect of time spent working on BMI increases by 9.9 and 17.3 % from the baseline estimates for women and men, representing 0.25 pounds and 0.24 pounds for every 10 h worked, respectively. After screen time, the time use channels associated with the largest differences in the estimated effect of time spent working on BMI are exercise for women (0.019) and sleeping for men (0.027). Accounting for these channels, the effect of time spent working on BMI falls by 4.5 and 13.7 % from the baseline estimates for women and men, representing 0.11 pounds and 0.19 pounds for every 10 h worked, respectively. Other time use channels associated with differences in the estimated effect of time spent working on BMI for women include food preparation (0.014), associated with a decrease in the effect of time spent working on BMI of 3.3 % from the baseline estimate, and commuting (−0.013) and secondary eating (−0.008), associated with increases in

[17] Weight in pounds is calculated as BMI multiplied by height in inches squared and then divided by 703. The magnitudes of the effects are calculated as the difference in weight in pounds before and after adding the coefficient estimates to average BMI, multiplying by average height in inches squared, and then dividing by 703. Average height and BMI are calculated from the analysis sample using sample weights. Average BMI is calculated to be 27.0 for women and 28.2 for men. Average height is calculated to be 64.5 inch. for women and 69.9 inch. for men. Calculation of changes in weight associated with effects estimated throughout the paper will use these values for average BMI and average height.

Table 4 Change in effect of working hours on BMI by channel

	Women		Men	
	Non-strenuous weekly hours worked (10 h)	Strenuous weekly hours worked (10 h)	Non-strenuous weekly hours worked (10 h)	Strenuous weekly hours worked (10 h)
Baseline effect on BMI	0.424***	0.216	0.197**	−0.066
	(0.096)	(0.381)	(0.087)	(0.239)
Change in baseline effect on BMI by channel				
Primary eating (min)	0.009	0.005	0.003	0.027**
	(0.006)	(0.010)	(0.005)	(0.011)
Secondary eating (min)	−0.008**	0.004	−0.001	−0.024
	(0.004)	(0.006)	(0.002)	(0.019)
Secondary drinking (min)	0.007	−0.002	0.002	0.002
	(0.006)	(0.005)	(0.004)	(0.004)
Food preparation (min)	0.014*	0.017	0.001	0.000
	(0.007)	(0.017)	(0.005)	(0.001)
Grocery shopping (min)	0.001	0.001	−0.002	−0.002
	(0.004)	(0.005)	(0.002)	(0.003)
Purchasing prepared food (min)	0.000	−0.038	−0.002	−0.001
	(0.004)	(0.036)	(0.002)	(0.002)
Sleeping (min)	−0.006	−0.003	0.027**	0.022*
	(0.008)	(0.005)	(0.012)	(0.012)
Exercise (min)	0.019***	−0.010	0.004	0.002
	(0.007)	(0.037)	(0.003)	(0.004)
Housework (min)	0.015	0.004	0.011	0.004
	(0.012)	(0.007)	(0.007)	(0.005)
Screen time (min)	−0.042***	−0.051	−0.034***	−0.049***
	(0.011)	(0.039)	(0.011)	(0.018)
Commuting (min)	−0.013*	−0.012	0.003	0.000
	(0.007)	(0.012)	(0.006)	(0.002)
Own medical care time (min)	−0.007	−0.001	0.000	0.000
	(0.006)	(0.003)	(0.001)	(0.001)
Observations	6,706		6,838	

Effects for non-strenuous weekly hours worked correspond to the coefficient for weekly hours worked; effects for strenuous weekly hours worked correspond to the linear combination of the coefficients for weekly hours worked and its interaction with the control for strenuous work. The first row presents the coefficient estimates for the ordinary least squares specification of the effect of working hours on BMI for the regression controlling only for individual characteristics, but not for any potential channels. The rest of the table reports the change in the coefficient estimates of the effect of working hours on BMI for each of the potential channels. Separately for men and women, each row presents the difference in the coefficients estimated from a separate regression. Regressions are weighted, with robust standard errors in parentheses. Specifications include state and year fixed effects as well as the individual demographic controls outlined in the Methods section. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

the effect of time spent working on BMI of 3.1 and 1.9 % from the baseline estimate.

Accounting for time spent in exercise, food preparation, and sleeping, the effect of time spent working on BMI becomes smaller in magnitude, shown by the positive difference in the effect of hours worked. This suggests that as individuals work longer hours, they spend less time in these activities since exercise, food preparation, and sleeping are all negatively related to BMI.[18] Accounting for screen time, time spent in secondary eating, and time spent commuting, the positive effect of time spent working on BMI becomes larger in magnitude, shown by the negative difference in the effect of hours worked. With regard to screen time, this follows since screen time is positively related to BMI and individuals engage in less screen time when they work more. With regard to secondary eating, Hamermesh (2010) shows that secondary eating is negatively related to BMI, so it can be inferred that individuals engage in more secondary eating when working longer hours. With regard to commuting, if time spent commuting is generally sedentary, time spent commuting is positively related to BMI, and it can be inferred that working more is associated with spending less time commuting.

For workers in non-strenuous jobs, we see that the number of channels that are statistically significant for women is greater than that for men and the effects for most channels are much larger in absolute value for women than for men. This could be the result of differences in women's and men's allocation of time due to differences in their wages. If women earn lower wages than men, we might see them work fewer hours, as shown in Fig. 1, and spend more time in home production, as shown, for example, by time spent in food preparation and housework in Table 2. In particular, as outlined by Grossbard-Shechtman (1984) and Grossbard (2015), coupled women have an incentive to devote even more time to home production since they can also get "paid" by their partners for the time they spend in Work-In-Household (WiHo) that benefits their partners.

Some of the time use channel results that support this argument include the significant effects of time spent in exercise and time spent in food preparation for women, but not for men. For example, it could be that the marginal time spent in exercise related to time spent in work may be more important for women than for men since women spend less time exercising less than men, as shown in Table 2 and Saffer et al. (2013). This result follows if women, on average, engage in more total work time including market work and home production, and it is the time spent in total work that influences exercise time. The finding that the effect for food preparation is significant only for women could reflect threshold effects: there could be a minimum level of time in food preparation that translates into lower BMI. If women spend more time in home production and accordingly spend more time in food preparation, as shown in Table 2, their time spent in food preparation might exceed the threshold, while men's lesser time spent in food preparation might not exceed the threshold. When women spend more time working, their time spent in food preparation might fall below the threshold, which could have a large effect on BMI. Since men's initial time spent in food preparation may not exceed the cutoff, when men spend more time

[18] Colman and Dave (2013b) find that physical activity reduces BMI.

working, they might not be able to reduce their time spent in food preparation or the difference in their time spent in food preparation might not meaningfully affect BMI.

For workers in strenuous jobs, fewer of the tested channels appear to impact the effect of hours worked on BMI. For women employed in strenuous jobs, no effects of time use channels on the effect of time spent working on BMI are found. This could reflect differences in the effects of strenuous and non-strenuous work for women or it could be reflective of the small number of women employed in non-strenuous jobs in the analysis sample. For men in strenuous jobs, the time use channels found to be significant include those found to be significant for men in non-strenuous jobs but also include a strong positive effect of time spent in primary eating. Since time spent in primary eating is negatively related to BMI, it follows that with working longer hours, individuals spend less time engaging in primary eating, and thus by including this channel in estimating the effect of hours worked on BMI, the effect of hours worked is lessened.

5.3 Results controlling for all time use channels

Results of the baseline specification including all time use controls are presented in Table 5. For both men and women, there are significant negative effects of time spent in secondary eating, exercise, and housework and significant positive effects of time spent in screen time on own BMI. For women, there are significant positive effects of time spent in purchasing prepared foods and secondary drinking and negative effects of time spent in grocery shopping. For men, there are significant negative effects of time spent in primary eating and sleeping. For the most part, the channels with significant changes in effects on work hours were all found to be significant determinants of BMI.[19] These results lend support to the notion that these are credible channels through which time spent working might affect BMI.

For both men and women employed in non-strenuous jobs, we still see the effect of hours worked on BMI to be positive and significant after including all of the tested time use channels. We would expect that if working hours affect BMI through these tested time use channels, the coefficient on BMI should fall in magnitude with the inclusion of these channels in the specification. Indeed, for women employed in non-strenuous jobs we see the effect of 10 h spent working on BMI decrease from 0.424 to 0.253 suggesting that for women, the effect of working time on BMI is augmented by the effect of working time on time spent in other activities. However, for men employed in non-strenuous jobs we see the effect of 10 h spent working on BMI increase from 0.197 to 0.252. This finding suggests that the inclusion of the tested time use channels mitigates the effect of hours worked. Taken together, the findings for men and women may reflect that men substitute work time for time spent in sedentary activities while women substitute work time for time spent in physically demanding and healthy food- and eating-related activities, consistent with the analysis by channel suggesting that time spent in work, women spend less time in a greater number of activities associated with lower BMI.

[19] The exceptions are food preparation and commuting, which were found to only have a marginally significant change in the effect of hours worked on BMI for women.

Table 5 Results for effect of working hours on BMI including all time use channels

	Women	Men
Weekly hours worked (10 h)	0.253***	0.252***
	(0.077)	(0.066)
Strenuous work × weekly hours worked (10 h)	−0.088	−0.191
	(0.332)	(0.194)
Primary eating (min)	−0.002	−0.004***
	(0.002)	(0.001)
Secondary eating (min)	−0.002***	−0.001**
	(0.001)	(0.001)
Secondary drinking (min)	0.001*	0.000
	0.000	0.000
Food preparation (min)	−0.002	−0.002
	(0.001)	(0.002)
Grocery shopping (min)	−0.004*	0.001
	(0.002)	(0.002)
Purchasing prepared food (min)	0.045***	0.014
	(0.013)	(0.014)
Sleeping (min)	0.000	−0.001***
	(0.001)	0.000
Exercise (min)	−0.009***	−0.003***
	(0.002)	(0.001)
Housework (min)	−0.002***	−0.001**
	(0.001)	0.000
Screen time (min)	0.003***	0.002***
	(0.001)	0.000
Commuting (min)	−0.004	−0.002
	(0.003)	(0.001)
Own medical care time (min)	0.002	0.003
	(0.002)	(0.002)
Observations	6,706	6,838

Shown are coefficients estimated from the specification of the determinants of BMI including all time use controls separately for men and women. Each column presents results from a single regression. Regressions are weighted, with robust standard errors in parentheses. Specifications include state and year fixed effects as well as the individual demographic controls outlined in the Methods section. The sample includes all individuals from the 2006–2008 ATUS ages 25–64 who were employed, not enrolled in school, and did not have missing data

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

5.4 Additional results

Given that a relationship was found between working time and BMI and that some eating, health investment, and physical activity channels were identified as mediating this relationship, the analysis proceeds to examine whether a similar relationship exists between time spent working and health status. If individuals who work longer hours have higher BMIs because they engage in less physical activity and if increased physical activity is associated with better health, it may follow that individuals who work longer hours also have worse health. In addition, while the other tested channels aside from those related to physical activity did not appear to strongly mediate the effect of working hours on BMI, health may be affected by working hours through these channels independently of BMI.

To test this relationship, the analysis examines whether working hours appear to have a significant effect on self-reported health status. The health measure available in the ATUS is self-reported health status, which consists of a scale from 1 (excellent) to 5 (poor). The analysis performs the baseline analysis using a linear probability model specification and using as the dependent variable an indicator for self-reported health status of very good or excellent. Coefficient results for these specifications are presented in Table 3.[20,21] Results do not suggest a relationship between working time and self-reported health status for either workers in non-strenuous jobs or workers in strenuous jobs. This could reflect that time spent working might affect BMI and not health status. Alternatively, this could reflect selection into hours worked based on health status or bias by working hours in the self-reporting of health status. These findings warrant future research on the relationship between time spent working and health outcomes.

6 Robustness

To consider the robustness of the analysis, alternative estimations are performed. These estimations consider alternate classifications of strenuous jobs and an alternate functional form.

6.1 Classification of strenuous jobs

Throughout the analysis, I estimate results separately for workers in non-strenuous jobs and workers in strenuous jobs. I classify jobs as strenuous if the MET value associated with the occupation is greater than or equal to 3.3. I use a MET value cut-off of 3.3 to be consistent with the methodology used by Zick et al. (2011). To test whether the analysis is sensitive to the choice of cut-off, I re-estimate the results first including as strenuous occupations with MET values greater than or equal to 2.9 (including installation, maintenance, and repair occupations, MET value = 3.2) and then including as strenuous only occupations with MET values greater than or equal to 3.7 (excluding building and grounds cleaning and maintenance occupations, MET value = 3.6). The results are robust to these alternative classifications.[22]

[20] The specifications include all of the individual demographic controls used in the BMI regressions with the exception of poor health status.

[21] Including a control for overweight status yielded qualitatively similar results.

[22] Results available from the author upon request.

6.2 Functional form

In the main analysis, I estimate ordinary least squares specifications. As a robustness check, I estimate loglinear specifications for the effects of time spent working on BMI. The magnitude and significance of the marginal effects of the loglinear specifications are consistent with the OLS coefficient results (see Footnote 22).

7 Discussion and conclusions

This paper investigated the channels that may be driving the relationship between time spent working and BMI. Estimations used the 2006, 2007, and 2008 ATUS linked with Eating and Health module interviews and the Compendium of Physical Activities. The analysis replicated the results of other papers finding a positive and significant relationship between working time and BMI for both men and women employed in non-strenuous jobs, but not for those employed in strenuous jobs. The paper then estimated a series of equations to determine whether a variety of potential mediators significantly change the estimated effect of time spent working on own BMI.

A number of the tested channels appear to impact the effect of hours worked on BMI. For workers in non-strenuous jobs, the effect of time spent working on BMI becomes smaller after accounting for time spent sleeping for both men and women and time spent in exercise and food preparation for women only. However, the effect of time spent working on BMI becomes larger after accounting for screen time for both men and women and time spent in secondary eating and commuting for women only. The single time use channel associated with the largest differences in the estimated effect of time spent working on BMI was screen time for both men and women employed in non-strenuous jobs. No effects were found for any channels for women working in strenuous jobs, and effects for men working in strenuous jobs were similar to those found for men working in non-strenuous jobs. Results are robust to the alternate classifications of occupations as strenuous and to the use of a loglinear functional form. Specifications examining the relationship between working hours and self-reported health status found no significant relationship.

Differences in women's and men's allocation of time due to differences in their wages could drive the findings that more channels are statistically significant for women than for men and that the effects for most channels are much larger in absolute value for women than for men. If women earn lower wages than men, we might see them work fewer hours and spend more time in home production. Then, changes in time spent working could have a bigger impact through time use channels for women given their larger initial allocation of time to home production activities and the effect on BMI of a marginal amount of time spent on different time use channels. The findings of significant effects of time spent in exercise and time spent in food preparation for women, but not for men, support this explanation.

An interesting finding of the analysis is that for women employed in non-strenuous jobs we see a decrease in the effect of working time on BMI after including all of the tested time use channels in the baseline specification while we see a decrease for men employed in non-strenuous jobs. This result suggests that for women employed in non-strenuous jobs the effect of working time on BMI is augmented by the effect of working time on time spent in other activities while for men employed in non-strenuous jobs the inclusion of the tested time use channels mitigates the effect of working time. Taken together, the findings for men and women may reflect that men substitute work time for time spent in sedentary activities while women substitute work time for time spent in physically demanding and healthy food- and eating-related activities, consistent with the analysis by channel suggesting that with increased time spent in work, women spend less time in a greater number of activities associated with lower BMI.

While the results of this study are valuable, there are several limitations. Because the relationships between one's own time spent working, one's own time in health-related activities, and one's own BMI may be due not only to a direct causal link, but also to some unobservable characteristics which result in these correlations or to reverse causation, findings from this approach must be interpreted as highly suggestive and not necessarily causal.

Another limitation to this study is its focus on the effect of working hours on BMI separate from income or wages. A number of papers have found negative relationships between income and obesity (Chou et al. 2004 and Rashad et al. 2006, among others) and wages and obesity (Baum and Ford 2004; Cawley 2004; Kim and Leigh 2010, among others). To attempt to determine the effect of hours worked separately from these factors, I include a control for weekly earnings in each of the specifications used in this analysis, but this may not be sufficient to identify distinct effects. For example, after controlling for weekly earnings this paper finds that more hours worked are associated with a higher BMI. However, if hours worked are also associated with more income, then after controlling for income, we would expect the estimated effect of hours worked to understate the true effect. Alternatively, if workers with low wages work longer hours than workers with high wages, the estimated effect on hours worked might overstate the true effect. Further research investigating the distinct effects of wages and hours worked on BMI would be valuable.

An alternative analysis could use time spent in the activity multiplied by the MET value associated with the activity to use a measure of activity duration and intensity as in Saffer et al. (2013) and Colman and Dave (2013a). Since the specific interest of this paper is to measure the effects of time use rather than physical activity, only measures of duration were used in this analysis. For the measure of working time, using this alternative measure would muddle the effect of time spent working and the intensity of the occupation. For the time use channels, using the alternative measure would capture changes in intensity as well as duration and accordingly would identify if, as individuals work more hours, they substitute within channels to lower intensity activities. Most of the tested channels are comprised of activities that are fairly uniform in intensity (primary eating, secondary eating, secondary drinking, food preparation, grocery shopping, purchasing prepared food, sleeping, screen time, own medical care); for these channels, estimates capturing duration intensity should not differ greatly from those capturing only duration. For the three categories comprised of less uniform activities (exercise, housework, commuting), if individuals substitute their time from higher MET value activities to lower MET value activities within each activity category, the analysis used in this paper would underestimate the effect of these channels on the effect of working time on BMI.

The results of this analysis suggest several topics for further research. Further analysis on the relationship between working time and obesity could examine mediating channels separately for single and married individuals and individuals with and without children. In addition, since a drawback of the dataset used in this analysis is that it is not possible to control for endogeneity, further work using data that allows for identification of an exogenous change in work hours would allow for a potential causal interpretation of results. A topic for future work could include examining more closely the role of physical activity on BMI and health over time and the relationship of physical activity to the consumption of unhealthy foods. It would also be interesting to examine if these relationships vary across ethnic groups and if there could be thyroid, metabolic, or genetic factors driving these results.

This study contributes to the literature in several ways. First, while other papers have examined the effect of the business cycle on health behaviors and outcomes, this paper specifically considers the difference in outcome for a worker's marginal hour of work by examining workers' time spent on the job. Further, building on the literature finding a relationship between working time and BMI, this paper investigates the potential eating, health investment, and physical activity channels driving this relationship to obtain a fuller picture of how work time affects lifestyle choices that affect weight and health. This is valuable because as the nature and duration of work changes for Americans, the full consequences of increased work hours are not explored in the literature and can have significant implications for policy.

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