Early to Work, Early to Rise? Gender Differences in the Relationship of Wake Time to Employment and Childcare Schedules among Working-Age U.S. Adults

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Abstract
Sleep duration predicts health and mortality, and, all else equal, people who wake up earlier sleep less. Prior studies have examined which activities help determine wake time, but little research has analyzed social variation in the relationship of wake time to these activities. Given gender differences in social expectations and sociodemographic characteristics surrounding work and family, the present study investigates whether the relationship of wake time to employment and childcare schedules differs by gender. Using data from the 2003-2016 years of the American Time Use Survey (ATUS), I find that earlier employment start times are associated with earlier wake times, but somewhat less so for women than men. I do not find significant gender differences in the association between childcare start time and wake time. These findings highlight the importance of considering social differences in how employment schedules shape sleep timing.

Abbreviated Introduction

How long we sleep has implications for health and mortality (Altman et al. 2012; Cappuccio et al. 2010; Jike et al. 2017; Magee, Caputi, and Iverson 2011).[1] Prior research has established that sleep duration varies according to several social factors, such as socioeconomic status (Basner, Spaeth, and Dinges 2014) and gender (Burgard and Ailshire 2013), raising the possibility that social variation in sleep contributes to health disparities (Hale, Peppard, and Young 2007). However, less research has focused specifically on social variation in what time people wake up from sleep and what factors influence wake time. Given that bed time and sleep interruption also contribute to sleep duration, it remains to be seen how closely social differences in wake time and its determinants parallel social differences in overall sleep duration. Better understanding social variation in wake time and its determinants would provide a more nuanced picture of the forces producing social variation in sleep, potentially informing interventions designed to improve sleep duration.

Later work and school start times are associated with longer sleep duration, likely due, at least in part, to their relationship with wake time (Basner et al. 2014; Owens, Belon, and Moss 2010). Although working-age adults are less likely to be enrolled in school than children, school start times might indirectly affect adults' wake time if they are caring for children before school; care work (including of household children) is one of the ten most common activities individuals perform in the two hours after waking up in the morning (Basner and Dinges 2009). Given gender differences in time use surrounding employment and childcare (Basner et al. 2007;

[1]Compared to moderate sleep durations (e.g. seven hours of sleep), both long and short sleep durations are associated with an increased risk of health problems and mortality (Altman et al. 2012; Cappuccio et al. 2010). Although uncertainty remains regarding the causal direction of the relationship between sleep duration and health outcomes (Magee et al. 2013), causal pathways linking sleep to future health problems are clearer for short-duration, compared to long-duration, sleep (Knutson and Turek 2006; Spiegel, Leproult, and Van Cauter 1999).

Bianchi et al. 2012), the present study examines whether the relationship of wake time to employment and childcare schedules differs by gender among working-age adults in the United States.

We might expect the relevance of employment and childcare for wake time to vary by gender for three main reasons. First, men and women differ in the *amount of time* they dedicate to paid work and childcare, with men spending more time in paid work and women more time in childcare, on average (Basner et al. 2007; Bianchi et al. 2012). If a woman performs no paid work on a given day, then paid work cannot be a determinant of the time she wakes up. Likewise, if a man performs no childcare on a particular day, then childcare does not impact his wake time.

A second reason why the relationship of wake time to employment and childcare might differ by gender is that the *timing* of employment and childcare activities might differ between men and women. For example, evidence suggests that gendered social norms surrounding care activities contribute to women's higher likelihood of interrupting their sleep to care for household members as night, including care of children (Burgard 2011; Venn et al. 2008). If waking up early in the morning to care for children is perceived as women's responsibility, women might perform childcare at earlier hours than men. Even in a case where a man and woman performed the same *number* of childcare hours, if the woman were performing childcare in the morning and the man at night, childcare might be a more important determinant of wake time for the woman, due to its temporal proximity to the time she wakes up.

Finally, even if men and women were to participate in employment and childcare at the same time, the *association* between the timing of these activities and wake time might differ by gender. Evidence suggests that gender informs approaches to sleep as a health behavior (see

discussion in Burgard and Ailshire 2013). Men and women might also view the relationship of work and family demands with sleep differently (Hislop and Arber 2003; Meadows et al. 2008).

Of the three possible mechanisms explaining why the relationship of wake time to employment and childcare schedules might differ by gender, the first is already well established: prior research has shown that women and men differ in the amount of time spent on childcare and employment activities (e.g. Basner et al. 2007; Bianchi et al. 2012). Thus, the present study focuses on the second two mechanisms: gender differences in the timing of childcare and employment, and gender differences in the associations of childcare and employment timing with wake time.

Methods

Data

I use data from the American Time Use Survey (ATUS), years 2003-2016, downloaded from the ATUS Extract Builder (Hofferth, Flood, and Sobek 2015, 2017). The ATUS is a cross-sectional, nationally representative sample of the non-institutionalized, civilian population aged 15 years and older in the United States (Bureau of Labor Statistics 2016). ATUS respondents are a subsample of the Current Population Survey (Bureau of Labor Statistics 2016).

ATUS respondents completed a single time diary that covered activities starting at 4am the day prior to the interview to 4am the interview day (Bureau of Labor Statistics 2016). Time diaries span all days of the week. I restrict my sample to respondents whose time diary covered a weekday (defined as Monday through Friday and not including holidays), given that activities potentially affecting wake time, such as employment, vary between weekdays and weekends.

Given changes in employment activities across the life course (Basner et al. 2007), I limit my sample to working-age adults, defined as individuals 18-64 years old, following Burgard and

Ailshire (2013). I further restrict my sample to respondents who woke up from sleep on the diary day (using the definition of wake time provided in the following section below). Of respondents meeting all other sample criteria, 12.34% of men and 7.78% of women did not meet "wake time" criteria on their diary day; this gender difference is statistically significant ($p<0.001$). I exclude respondents who are missing data on any of the covariates used in this analysis (Around .16% of weekday respondents aged 18-64 years old are missing data).

In regression models, I analyze subsamples that include only those respondents who reported the activity under analysis on their diary day. Thus, in regression models that use employment start time to predict wake time, I only include respondents who reported working on their diary day. Similarly, in regression models that predict wake time using childcare start time, I only analyze respondents who reported performing childcare on their diary day. In these models, I exclude respondents who started employment/childcare prior to their wake time or after 12:00pm.

Measures

Wake time is defined as the termination of the first sleep episode ending prior to 12:00 p.m. after which the respondent was awake for at least two hours. This coding is roughly similar to procedures used in Basner and Dinges (2009). Wake time is measured in number of hours past midnight. Thus, 7:30am would be represented as 7.5 hours. Minutes after wake time is defined as the number of minutes that have passed in the two-hour period after wake time, broken into five-minute increments.

Employment and childcare activities are determined using ATUS activity codes. Employment activities include all ATUS activity codes in the 05 "Work and Work-Related Activities" (first-tier activity code) category (Bureau of Labor Statistics 2016; U.S. Bureau of Labor Statistics n.d.:3), as well as ATUS activity codes in the work-related travel subcategory

(codes starting with 1805) (U.S. Bureau of Labor Statistics n.d.:9). Childcare includes ATUS activity codes falling under the following (second-tier activity code) categories: "Caring for & Helping HH [Household] Children" (0301), "Activities Related to HH [Household] Children's Education" (0302), and "Activities Related to HH [Household] Children's Health" (0303) (U.S. Bureau of Labor Statistics n.d.:2). Travel related to these activities (activity codes 180301-180304 in the ATUS-X coding system) (Minnesota Population Center 2018) are also considered childcare.

For both employment and childcare, a continuous measure provides the activity (i.e., employment or childcare) start time in number of hours (past midnight). In regression models, these measures are centered at 8:00 a.m. A categorical measure breaks activity start times down into the following categories: 4:00am, 4:00am-5:59am, 6:00am-6:59am, 7:00am-7:59am, 8:00am-8:59am, 9:00am-9:59am, 10:00am-11:59am, 12:00pm or later, and not applicable—because the respondent did not report any episodes of that activity on their diary day.

The number of hours the respondent spent in a given activity on the diary day represents the number of hours the respondent participated in that activity across the full 24-hour time diary. For the purposes of graphical representation, engagement in a given activity is an indicator of whether the respondent participated in that activity within a certain five-minute interval in the two hours after the respondent woke up.

Control covariates include indicators of region (northeast, midwest, south, or west), season (winter, spring, summer, or fall), day of week (Monday, Tuesday, Wednesday, Thursday, or Friday) and whether the ATUS interview took place after the 2008 recession. (Evidence suggests that the 2008 recession affected both employment and sleep (Aguiar, Hurst, and Karabarbounis 2013).) In regression models, I also control for age (centered at the overarching sample mean), age (centered) squared, education (less than high school, high school, associate's

degree or some college, or college or advanced degree), race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or other), whether the respondent was born outside of the United States, whether any children under the age of 18 live in the respondent's household, and whether the respondent co-resides with a partner.

Analysis

I first examine descriptive statistics of wake time, as well as the duration of men's and women's employment and childcare activities across the full diary day. I then graph the proportion of respondents engaged in employment or childcare activities in the two hours after waking up on the diary day, similar to procedures used in Basner and Dinges (2009), but broken down by gender. Next, I analyze descriptive statistics of start time measures for employment and childcare activities, broken down by gender.

Finally, I run a series of OLS regression models to examine gender differences in the associations of childcare and employment start times with wake time. These models are restricted to the employment/childcare subsamples described above. All models include region, season, day of the week, and an indicator of whether the ATUS interview was post-2008 as control covariates. Each model also includes covariates for age, age squared, education, race/ethnicity, and whether the respondent was born outside of the United States. Each model includes a quadratic term for the activity (i.e., employment or childcare) start time of interest, to account for the fact that the association between an activity's start time and wake time might diminish at later activity start times. Model 1 of each analysis set uses the activity (i.e., employment or childcare) start time terms to predict wake time and includes interactions between the activity start time terms and gender. Model 2 mirrors Model 1 but adds the following covariates: whether the respondent lives with a partner and the number of hours the

respondent spent in the activity of interest on the diary day. For the employment start time analysis, Model 2 also adds a covariate indicating whether the respondent lives with children.

All analyses were conducted in Stata/SE 14.2 using recommended probability weights and successive difference replicate weights to calculate standard errors (Bureau of Labor Statistics 2016; U.S. Census Bureau 2006).

Preliminary Results

Table 1 displays descriptive statistics for wake time, as well as employment and childcare schedule variables across the full sample. Results suggest that both women and men have an average wake time that falls in the 10 minutes prior to 7:00am. The gender difference in wake time is around five minutes and is statistically significant, with men waking up earlier than women, on average.

Gender differences in time spent in employment and childcare (displayed in Table 1) are consistent with findings from prior research (Basner et al. 2007; Bianchi et al. 2012): men spend more time in employment, on average, and women more time in childcare. Moreover, compared to men, a larger proportion of women reported no employment activities on the diary day. A larger proportion of men than women reported no childcare activities on the diary day.

Table 1 examines employment and childcare across the full diary day. Figures 1 and 2 display engagement with employment and childcare specifically in the two-hour period after respondents wake up. Gender differences in the proportion of respondents engaged in employment activities (graphed in Figure 1) expand from wake time to approximately one-hour post-waking. At nearly two hours post-waking, around 49% of men are working, compared to only 31% of women.

Results for childcare, displayed in Figure 2, suggest that a larger proportion of women than men are engaged in childcare in the two hours following wake time. However, gender differences in childcare engagement do not display the same pattern of clear increase across this time period as shown for employment engagement.

Gender Differences in the Timing of Employment and Childcare

To address whether the timing of employment and childcare activities varies by gender, Tables 1 and 2 present gender differences in the distribution of respondents across employment and childcare start times. Table 1 presents results for the full analytic sample, and Table 2 restricts results to the employment and childcare subsamples, comprised of respondents who had eligible employment or childcare (respectively) start times on the diary day.

Examining employment and childcare start times in the full analytic sample (Table 1) helps us understand gender differences in selection into the subsamples. In particular, Table 1 shows the distribution of respondents with activity start times at 4:00 a.m. (the diary start) or at 12:00 p.m. or later. These start times render respondents ineligible for the subsamples used in regression analysis. Men are more likely to be engaged in work activities at the diary start, but women are more likely to be performing childcare at this time. There is no gender difference in the proportion of respondents starting work at 12:00 p.m. or later, but men are more likely than women to start childcare during this time period.

Because Table 1 displays descriptive statistics for the full sample, observed gender differences in the proportion of respondents starting a given activity at a given time might reflect gender differences in the probability of doing said activity at all during the diary day. To address this issue, Table 2 displays gender differences in employment and childcare start times, but limited to the subsample of respondents who had eligible employment or childcare (respectively)

start times on the diary day. Limiting the sample to respondents who engaged in the activities of interest also allows me to examine a continuous measure of start time (this was not possible in the full sample, because start times are not available for respondents who never started a given activity).

Results for the continuous measure of employment start time (displayed in Table 2) show that conditional on having an eligible employment start time on the diary day, women have later employment start times than men, on average. Women start work activities around 7:46 a.m., on average, whereas men start work activities around 7:20 a.m. Results from categorical measures of employment start time are consistent with the finding that women have later employment start times than men.

Analysis of the continuous measure of childcare start time (Table 2) shows that among respondents with an eligible childcare start time, women start providing childcare marginally significantly later than men. However, this difference should be contextualized within the Table 1 results showing that men in the full sample are more likely to start childcare at or after 12:00 p.m. Respondents who start childcare at or after 12:00 p.m. are ineligible for the subsample of respondents examined in Table 2. Overall, although a few significant gender differences in childcare start times are observed in Table 2, they do not paint a clear picture of striking gender difference.

Gender Differences in Associations of Wake Time with Employment and Childcare Start Times

To examine whether the associations of wake time with employment and childcare start times vary by gender, I present results from multivariate regression models in Tables 3 and 4. Table 3 presents results for employment start time, and Table 4 presents results for childcare start time. Model 1 within each analysis set examines how the start time of the activity under

examination (i.e., employment or childcare) associates with wake time, and whether this association differs by gender. Model 1 includes a variety of interview and sociodemographic measures as covariates. Model 2 adds measures of household composition and duration of time spent in the activity of interest on the diary day.

Results in Table 3 suggest that starting work later is associated with waking up later. For men, at 8:00 a.m., starting work one hour later is associated with waking up around .65 hours, or 39 minutes, later. However, the association between employment start time and wake time diminishes slightly at later wake times, as evidenced by the statistically significant and negative quadratic term for employment start time.

The association between employment start time and wake time is attenuated among women. For example, at 8:00 a.m., starting work one hour later is associated with waking up around 34 minutes later for women (compared to the 39-minute delay in wake time observed for men). There is a negative interaction between the employment start time squared term and gender, suggesting that the association between employment start time and wake time diminishes at a slightly faster rate among women. However, this association is relatively small and is only marginally statistically significant. Adding covariates related to household composition and employment hours in Model 2 does not substantially change these results.

Table 4 results show that later childcare start times are associated with later wake times. For men, at 8:00 a.m., a one-hour later childcare start time is associated with an approximately .60-hour, or 36-minute, delay in wake time. However, similar to results observed for employment start time, the association between childcare start time and wake time diminishes at later childcare start times. I do not observe significant gender differences in the association between childcare start time and wake time, and these results do not substantially change in Model 2 when adding covariates related to household composition and childcare hours.

Abbreviated Discussion

Overall, these results suggest that employment schedules play a more substantial role in shaping men's than women's wake time. On the weekdays observed, men are more likely to work, including during the two-hour period following the time they wake up in the morning. On average, women who reported employment activities on the diary day started these activities later than did men. Moreover, results suggest that the association between wake time and employment start time is somewhat stronger among men.

However, results were more mixed regarding gender differences in the relevance of childcare schedules to wake time. Overall, women are more likely to engage in childcare on weekdays, including during the two hours following their morning wake time. This evidence supports the idea that gender variation in the participation rates and timing of childcare might contribute to gender differences in the relevance of childcare activities to wake time. However, conditional on providing childcare within the more limited time period I examine in regression analysis, I did not find evidence that the association between childcare start time and wake time differed by gender.

An important limitation of this study relates to causal inference: we cannot know the extent to which earlier employment or childcare start times truly cause earlier wake times—as opposed to other factors, such as individual chronotype and sleep preferences, impacting both employment/childcare start time and wake time (Hale 2014). Moreover, this study excludes ATUS respondents who did not have a qualifying wake time prior to 12:00pm. Thus, these results are not generalizable to individuals who have alternative sleep schedules, perhaps due to non-standard work hours.

Limitations notwithstanding, this research advances understanding of gender differences in sleep by providing a more nuanced analysis of timing than studies that examine total sleep duration only. In addition, these results are consistent with the idea that gendered work-family responsibilities and expectations contribute to gender differences in the determinants of wake time. This finding suggests that it would be fruitful for future investigation of wake time to consider how its determinants might be shaped by gender and other social factors.

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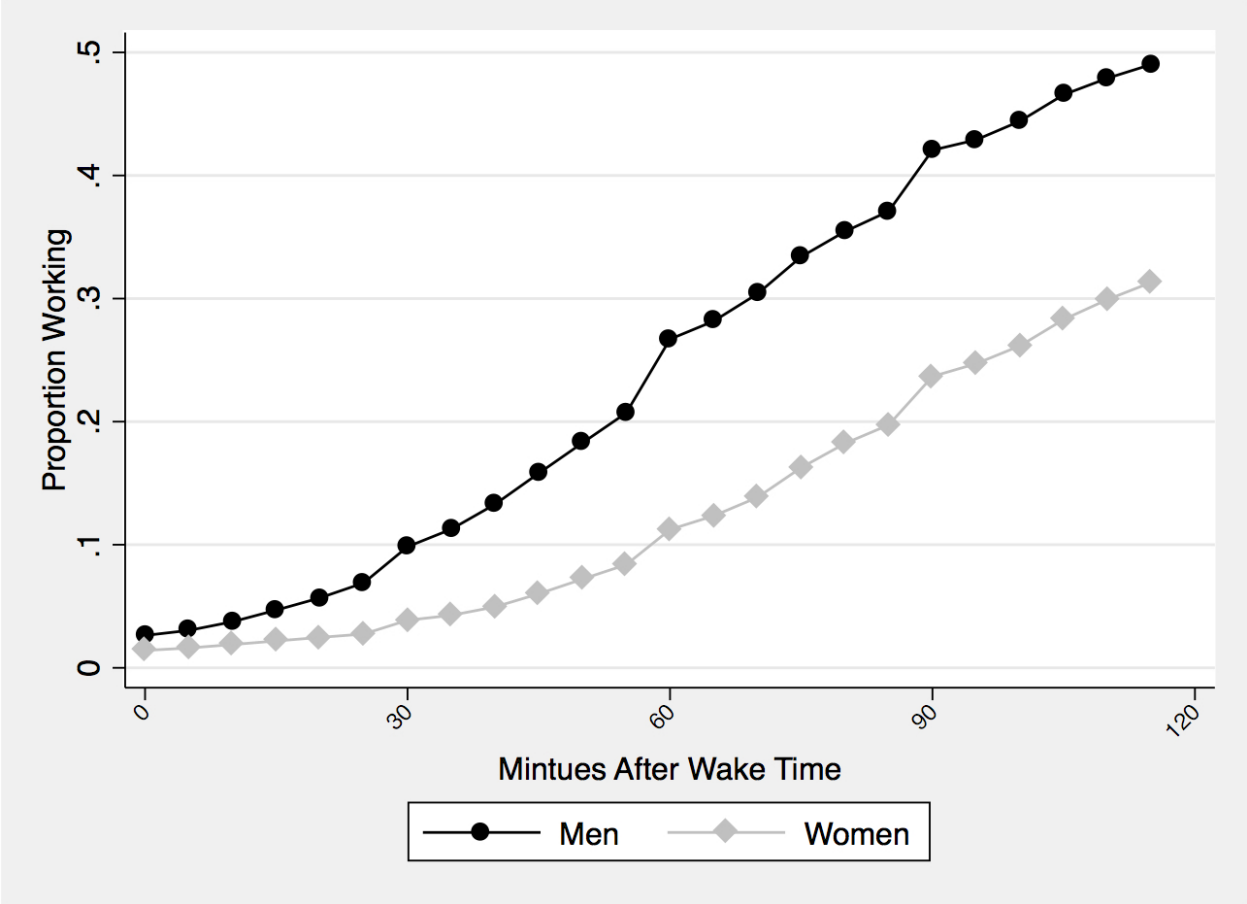
Table 1. Descriptive Statistics for Weekday Employment Activities, Childcare Activities, and Wake Time among ATUS Respondents 18-to-64 Years Old with Eligible Wake Time, by Gender

	Men (N=26,600)	Women (N=34,598)
Wake Time (in hours)	6.88	6.96***
	(1.26)	(1.28)
Employment		
Number of Employment Hours on Diary Day	6.48	4.58***
	(3.72)	(3.86)
Employment Start Time (categorical) (%)		
4:00 (diary start)	0.51	0.17***
4:00-5:59	8.32	2.81***
6:00-6:59	18.03	9.78***
7:00-7:59	20.25	18.67***
8:00-8:59	10.99	11.51
9:00-9:59	4.35	4.68
10:00-11:59	3.69	3.86
12:00 or later	6.88	6.81
Not applicable--no employment on diary day	26.97	41.71***
Childcare		
Number of Childcare Hours on Diary Day	0.37	0.93***
	(0.82)	(1.52)
Childcare Start Time (categorical) (%)		
4:00 (diary start)	0.13	0.65***
4:00-5:59	0.94	2.05***
6:00-6:59	3.74	9.27***
7:00-7:59	4.05	9.22***
8:00-8:59	1.29	3.26***
9:00-9:59	0.44	1.50***
10:00-11:59	0.62	1.61***
12:00 or later	10.41	8.63***
Not applicable--no childcare on diary day	78.38	63.80***

Gender difference significant at †p<.10; * p<.05; ** p<.01; *** p<.001

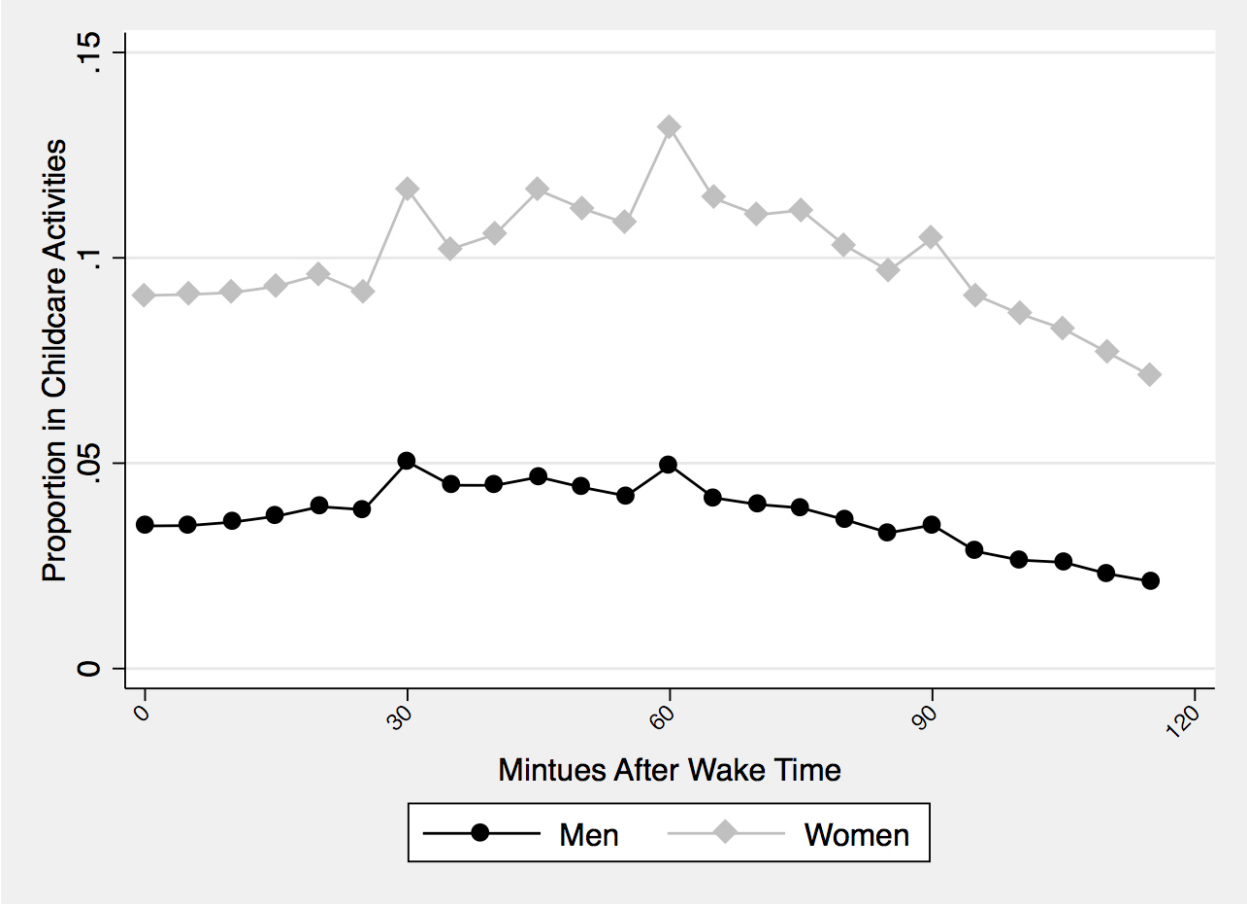
Source: American Time Use Survey (ATUS), 2003-2016. *Note:* Generated using probability weights; standard errors calculating using successive difference replicate weights. Standard deviations for continuous variables shown in parentheses.

Figure 1 Proportion of ATUS Respondents 18-to-64 Years Old (with Eligible Wake Time) Engaged in Employment Activities on Weekdays, by Gender and Number of Minutes after Wake Time



Source: American Time Use Survey (ATUS), 2003-2016. *Note:* Generated using probability weights. Each data point represents a five-minute increment of time beginning at its x-axis value.

Figure 2 Proportion of ATUS Respondents 18-to-64 Years Old Engaged in Childcare Activities on Weekdays, by Gender and Number of Minutes after Wake Time



Source: American Time Use Survey (ATUS), 2003-2016. *Note:* Generated using probability weights. Each data point represents a five-minute increment of time beginning at its x-axis value.

Table 2. Descriptive Statistics for Weekday Employment (Panel A) and Childcare (Panel B) Start Time among ATUS Respondents 18-to-64 Years Old with Sample-Eligible Wake Time and Work/Childcare Start Time, by Gender

	Men	Women
Panel A: Employment		
Employment Start Time (hours)	7.34	7.77***
	(1.10)	(1.15)
Employment Start Time (categorical) (%)		
4:00-5:59	12.60	5.40***
6:00-6:59	27.50	19.02***
7:00-7:59	30.87	36.43***
8:00-8:59	16.77	22.47***
9:00-9:59	6.64	9.13***
10:00-11:59	5.63	7.54***
N	18,127	18,135
Panel B: Childcare		
Childcare Start Time (hours)	7.24	7.30†
	(1.15)	(1.27)
Childcare Start Time (categorical) (%)		
4:00-5:59	7.86	6.86
6:00-6:59	33.78	34.10
7:00-7:59	36.78	34.71*
8:00-8:59	11.74	12.35
9:00-9:59	4.10	5.77**
10:00-11:59	5.73	6.21
N	3,921	11,630

Gender difference significant at †p<.10; * p<.05; ** p<.01; *** p<.001

Source: American Time Use Survey (ATUS), 2003-2016. *Note:* Generated using probability weights; standard errors calculating using successive difference replicate weights. Standard deviations for continuous variables shown in parentheses.

Table 3 Results from OLS Regression Models Predicting Weekday Wake Time among ATUS Respondents 18-to-64 Years Old with Eligible Employment Start Time

	Model 1	Model 2
Female	-0.26***	-0.25***
	(0.01)	(0.01)
Employment Start Time	0.65***	0.65***
	(0.01)	(0.01)
Employment Start Time Squared	-0.03***	-0.03***
	(0.00)	(0.00)
Female X Employment Start Time	-0.08***	-0.07***
	(0.01)	(0.01)
Female X Employment Start Time Squared	-0.01†	-0.01†
	(0.01)	(0.01)
Children in Household		-0.17***
		(0.01)
Partner in Household		-0.07***
		(0.01)
Diary Day Employment Hours		0.01***
		(0.00)
Constant	6.64***	6.72***
	(0.02)	(0.03)
R-squared	.59	.60
N	36,262	36,262

†p<.10; * p<.05; ** p<.01; *** p<.001
Source: American Time Use Survey (ATUS), 2003-2016. *Note:* All models control for region, season, day of interview, whether the interview took place after 2008, age, age squared, education, race/ethnicity, and whether the respondent was born outside of the United States.

Table 4 Results from OLS Regression Models Predicting Weekday Wake Time among ATUS Respondents 18-to-64 Years Old with Eligible Childcare Start Time

	Model 1	Model 2
Female	-0.08***	-0.10***
	(0.02)	(0.02)
Childcare Start Time	0.60***	0.60***
	(0.02)	(0.02)
Childcare Start Time Squared	-0.07***	-0.07***
	(0.01)	(0.01)
Female X Childcare Start Time	0.00	0.01
	(0.02)	(0.02)
Female X Childcare Start Time Squared	0.01	0.01
	(0.01)	(0.01)
Children in Household		0.00
		(0.02)
Partner in Household		0.03***
		(0.00)
Constant	6.98***	6.91***
	(0.03)	(0.03)
R-squared	.60	.61
N	15,551	15,551

†p<.10; * p<.05; ** p<.01; *** p<.001
Source: American Time Use Survey (ATUS), 2003-2016. *Note:* All models control for region, season, day of interview, whether the interview took place after 2008, age, age squared, education, race/ethnicity, and whether the respondent was born outside of the United States.