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Maternal Work and Children's Diet, Activity, and Obesity

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Paper No: 2013-012

CESR-SCHAEFFER WORKING PAPER SERIES

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This research was funded by a grant from the National Institute of Child Health and Human Development R01HD057193. All opinions are those of the authors and do not represent opinions of the funding agency.

Abstract

Mothers' work hours are likely to affect their time allocation towards activities related to children's diet, activity and well-being. For example, mothers who work more may be more reliant on processed foods, foods prepared away from home and school meal programs for their children's meals. A greater number of work hours may also lead to more unsupervised time for children that may, in turn, allow for an increase in unhealthy behaviors among their children such as snacking and sedentary activities such as TV watching. Using data on a national cohort of children, we examine the relationship between mothers' average weekly work hours during their children's school years on children's dietary and activity behaviors, BMI and obesity in 5th and 8th grade. Our results are consistent with findings from the literature that maternal work hours are positively associated with children's BMI and obesity especially among children with higher socioeconomic status. Unlike previous papers, our detailed data on children's behaviors allow us to speak directly to affected behaviors that may contribute to the increased BMI. We show that children whose mothers work more consume more unhealthy foods (e.g. soda, fast food) and less healthy foods (e.g. fruits, vegetables, milk) and watch more television. Although they report being slightly more physically active, likely due to organized physical activities, the BMI and obesity results suggest that the deterioration in diet and increase in sedentary behaviors dominate.

JEL: J22

Keywords: Maternal work hours, childhood obesity, BMI, diet, physical activity, sedentary behavior

1. Introduction

Childhood obesity in the U.S. has increased threefold over the last four decades (Ogden et al 2012). While the proximate causes are obvious – excess calories in versus calories out – the determinants of such energy imbalance are less well understood. Some have argued that explanations for such large increases lie in other societal trends that occurred contemporaneously (Sturm 2005a, Sturm 2005b). One such candidate is maternal labor supply. According to the Bureau of Labor Statistics (BLS), the labor force participation among mothers with school-age children increased dramatically during the same time period as the obesity epidemic. The proportion of mothers with a youngest child between 6 and 17 years of age who were employed increased from 51% in 1975 to 74% in 2005 (BLS 2011). It is therefore natural to examine whether maternal labor supply is linked to childhood obesity. Maternal work potentially influences mothers' time allocation toward activities related to children's diet, physical activity, and well-being (Cawley & Liu, 2012). For example, less time spent in household work (Bianchi, 2000) and meal preparation (Cutler, Glaeser & Shapiro, 2003) and greater consumption of meals prepared away from home (Kant & Graubard, 2004) have been documented in studies using samples from the U.S.. Another recent study shows that maternal employment is associated with reductions in time spent grocery shopping and cooking and with a greater likelihood of purchasing prepared foods (Cawley & Liu, 2012). Foods not prepared at home, in turn, have been linked to a higher risk of childhood obesity (Institute of Medicine, 2005) because they have a higher fat density and lower nutrient density than foods prepared at home (Lin et al., 1999). Maternal work can also induce mothers to outsource meal preparation. Datar and Nicosia (2012a) find that maternal work decreases the likelihood of eating breakfast provided by the school, but increases the likelihood of eating lunch offered at the school. Recent studies suggest that while school breakfast may improve children's nutritional intake, school lunch may be linked to obesity (Millimet et al, 2010). Finally, greater maternal work is

also associated with children spending more time in the care of others or unsupervised, which may influence diet and activity if these children choose unhealthy foods (Klesges et al. 1991) and sedentary activities (Fertig et al. 2009). Although fathers' time with children has increased in recent decades, research shows that mothers still do more child-related work at home, regardless of their work status, and that fathers do not alter their time with children to make up for the time that mothers spend at work (Cawley & Liu, 2012).

In addition to the effects on time allocation, maternal work increases household income, which can affect children's energy balance. On the one hand, higher income enables mothers to purchase fresh high-quality foods and enroll children in organized physical activities. On the other hand, higher income could mean additional pocket money for children to spend on unhealthy foods (e.g. junk food in schools) or greater frequency of the family eating out, which may increase caloric intake.

A growing literature has examined the link between maternal labor supply and childhood obesity, mostly among younger children in the U.S. (Anderson, Butcher & Levine, 2003; Chia, 2008; Phipps et al., 2006; Ruhm, 2008; Anderson & Butcher, 2006; Fertig, Glomm & Tchernis, 2009; Liu et al., 2009; Morrissey, Dunifon & Kalil, 2011; Ziol-Guest et al. 2013). The emerging consensus is that maternal work hours are positively associated with children's Body Mass Index (BMI) and obesity, but fathers' hours are not. This relationship is typically stronger among higher socioeconomic families even though their obesity rates are lower. However, very little is currently known about the mechanisms through which maternal work hours influence children's weight. Recent time use studies have begun to shed some light on the potential mechanisms. Fertig et al. (2009) find that maternal employment is associated with fewer meals consumed by children (perhaps due to skipping meals) and more television watching, although these play a small role in explaining the link between maternal employment and childhood obesity. Cawley and Liu (2012) find that working mothers spend significantly less time in

grocery shopping, cooking, eating, and playing with their children and are more likely to purchase prepared foods. While these studies suggest that increased maternal work hours could *potentially* affect children's diet and activity behaviors in adverse ways, there is no direct evidence on how children's diet and activity are related to maternal work hours. Our review focuses on the U.S. context because the dataset used in this paper is also U.S. based. However, it should be noted, that the relationship between maternal work and childhood obesity is grounded in cultural, social, and institutional contexts. This relationship has been found to be insignificant in other locations such as Europe (Gwozdz et al 2013).

In this paper, we use data from the Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K) to first estimate the relationship between maternal work hours and children's BMI and obesity in a national cohort of U.S. children during their 5^{th} and 8^{th} grades. The aim of this first step is to replicate findings from prior studies that use different U.S data. The main contribution of this paper, however, is to examine the relationship between maternal work hours and children's dietary behaviors, physical activity, and sedentary behaviors in this national sample to gain insight into the potential mechanisms linking maternal work and childhood obesity in the U.S. We also consider whether these relationships differ by socio-economic status (SES) and whether they evolve as children transition into adolescence.

2. Conceptual Framework

Economic models of household behavior suggest that mothers allocate their time across household production, child care, work and leisure/sleep to maximize the household's overall utility, which includes children's health (Becker, 1981). Because available time is fixed, time allocated to market work restricts time spent on household production (e.g. meals), time with children, leisure/sleep or some combination thereof. Mothers may substitute time inputs for market goods in the production of child health, for example, by purchasing meals or enrolling children in organized activities or child care rather

than undertaking these activities themselves. The reallocation would depend upon the net marginal utility of time spent on these competing uses.

In this framework, the relationship between mother's work and BMI is determined through the effects on energy intake and energy expenditure. These effects are complex because the increase in household income due to mother's work (income effect) and the decrease in mother's time (time effect) may have opposing effects.

Time constraints mean that working mothers may have less time to prepare meals and less time to supervise their children's diet, which may be differentially important as children transition into adolescence and make more of their own choices. If mothers choose to reduce meal preparation time, they may increase reliance on pre-packaged or processed foods or by purchasing meals away from home (e.g. Cawley and Liu 2007; Kant & Graubard, 2004). These behaviors are associated with higher density foods and increased caloric intake (Lin et al., 1999). Even if mothers continue to prepare their own meals, they may have less time to supervise children's snacking because they are busy with other tasks or they substituted purchased child care for their own supervision, which may lead to more frequent or less healthy snacking (Brown et al. 2010). The time effect also suggests potentially deleterious consequences on energy expenditure if mothers have less time to supervise their children's activities (Cawley and Liu, 2012). Children may opt to spend more time in sedentary behaviors because they are less supervised or they are supervised by non-parents (Brown et al. 2010; Fertig et al. 2009). The time effect on energy intake and expenditure may be zero if working mothers reduce time spent on other activities such as leisure/sleep) (Bianchi 2000). However, negative consequences can persist if reducing leisure/sleep activities negatively influences the quality of the time that mothers continue to spend with their children.

The income effect is also ambiguous. On the one hand, higher income leads to greater ability to afford fresher and more nutritious foods, which can have beneficial effects because these foods are likely to be lower in fat and less calorie dense (Drewnowski and Specter 2004). Similarly, working mothers may be more able to afford opportunities for children's physical activity that are costly such as organized sports. On the other hand, higher income may increase opportunities for eating out at restaurants and increase pocket money for in-school junk food purchases, which can increase energy intake. Therefore, ultimately, the overall effect of maternal work on children's BMI and its underlying mechanisms is an empirical question.

Thus far, we have discussed the household allocation decision as revolving around the mother's time and decisions as if holding father's efforts constant. Clearly, fathers may also play a role in generating income and in providing time with the child and we explore this below. The literature, however, suggests that fathers do not substantially adjust their time in response to maternal work hours (Cawley and Liu 2012) and that their work hours do not influence obesity-related outcomes (Ziol-Guest et al. 2013).

Finally, an important aspect which informs the model is that behavior and health are not solely a function of contemporaneous factors, but rather an accumulation of previous and contemporaneous decisions (e.g. past weight gain, habit formation) (Ruhm 2008). Because behaviors and health in the current period are dependent on the previous period, parent's and children's choices regarding work, diet and activity have implications throughout children's lifetimes.

3. Empirical Strategy

We start with a basic Ordinary Least Squares (OLS) specification that models BMI (obesity) as a function of mother's work estimated cross-sectionally among 5th and 8th graders separately (Equation 1), where mother's work is averaged over the observation period (i.e. K-5 for 5th graders and K-8 for the 8th

graders). The vector (X) includes contemporaneous child, family and school covariates that are correlated with maternal work and children's BMI. The coefficient of interest is β_1, which captures the relationship between maternal work and children's BMI (or behaviors). Standard errors are clustered at the school level.

(1) $BMI_i = \alpha + \beta_1 H_i + \beta_2 X_i + \varepsilon_i$

For simplicity, assume that the "true" relationship between mother's work hours (H) and child BMI is positive. A basic OLS is potentially problematic because β_1 may be biased by heterogeneity between working and non-working mothers. On the one hand, working mothers may be high-ability mothers (Vandell and Ramanan, 1992; Waldfogel et al., 2002; Ruhm, 2004; Hill et al. 2005). If these mothers excel at work as well as home-making and child-rearing, then OLS estimates are likely to be biased downward because some observable and unobservable characteristics of these high-ability mothers may be protective. Alternatively, if working mothers are already less inclined to home-making and child-rearing activities even absent work hours, then OLS estimates are likely biased upward.

We implement two complementary approaches to address this concern. The first is to control for a rich set of observable factors that proxy for mother's ability and health preferences. The ECLS-K contains parents' reports of children's birth weight, disability, and health status as well as parents' self-reports of own health status. A complementary effort would control for unobservable factors that may not be captured by observable covariates. Other studies have used child-, sibling-, or mother-fixed effects approaches (Anderson, Butcher & Levine 2003; Ruhm 2008; Scholder 2008; Chia 2008), but an important limitation of this approach is the strong assumption that changes over time in maternal work occur for reasons exogenous to the outcome of interest. Studies have shown that child health has a strong positive effect on maternal labor supply (Corman, Noonan & Reichman, 2005; Gould, 2004), which implies that this assumption may be problematic. We attempt to control for unobserved

heterogeneity by including school fixed effects on the assumption that parents sort themselves into schools based on their ability, resources or preferences relating to child outcomes.

Prior studies also use local labor market conditions and child care regulations as instrumental variables (IV) for maternal labor supply. While IV models are appealing, finding strong and valid instruments has proven difficult. In particular, these instruments have often been weak predictors of mother's hours in the first stage (Anderson et al. 2003; James-Burdumy 2005; Scholder 2008; Chia 2008). In a sensitivity analysis we also estimate an IV model that uses the state's median unemployment rate and the median of the state's average weekly wage for private non-agricultural workers over the child's survey period (i.e. K-5 for 5th graders and K-8 for 8th graders) to instrument for average maternal work hours. Standard errors are clustered at the state level in the IV models. We also include other state-level covariates in the IV models including adult obesity prevalence and breastfeeding laws to address potential heterogeneity across states that may confound the IV estimates. All models are estimated separately for the children in 5th and 8th grades to assess whether the relationships evolve as children age.

Finally, we re-estimate the models separately for high- and low-SES households because the relative size of the income versus time effects may differ. For example, high-SES mothers may be able to afford to hire someone to prepare nutritious home meals or provide higher-quality child care to mitigate the negative consequences of the time effect. Alternatively, the loss of parental time spent with the child may be more deleterious for high-SES families if the quality of mothers' time spent with children is higher. Several studies suggest that high-SES children may be at greater risk with respect to BMI from maternal work (Araneo 2008, Fertig et al. 2009).

4. Data

We analyze data from the ECLS-K, a longitudinal survey of a nationally representative cohort of approximately 20,000 U.S. kindergarteners starting in the 1998-1999 school year (Tourangeau et al 2006). The ECLS-K, conducted by the National Center for Education Statistics, used a multistage probability sample design where the primary sampling units (PSUs) were geographic areas of counties or groups of counties across the U.S. Schools were sampled within PSUs and children were sampled within schools. Data were collected in fall of kindergarten and spring of 1st, 3rd, 5th and 8th grades on children's cognitive, health and developmental outcomes, and contextual data on their families, teachers and schools. While BMI and physical activity were collected in most waves, data on diet were only collected in the spring of 5th (2004) and 8th (2007) grades; hence these two waves are the focus of our analyses. Our analysis sample includes 9,940 and 8,580 children in 5th and 8th grade waves respectively, which represents 50% and 43% of the kindergarten sample. The primary source of attrition is children who changed schools from one wave to the next and were not selected for follow up. The attrition bias is minimized because the ECLS-K followed a random sub-sample of half the movers in each wave prior to 5th grade and all the movers between grades 5 and 8. Children with missing follow-up data were more likely to be Black and of lower socioeconomic status relative to those with complete data, but there were no statistically significant differences in mean BMI, obesity prevalence, percent male, and age at kindergarten. Descriptive statistics for the key outcome measures are reported in Table 1.

BMI and obesity: A distinct advantage of the ECLS-K is that it collected height and weight measurements. Measurements are superior to self- or parent-reports that may introduce non-random measurement error. Height and weight were each measured twice to minimize error. Composite height and weight were computed by ECLS-K staff from the two readings and then used to compute a composite BMI. We calculate age- and gender-specific BMI percentiles (pBMI) based on the 2000

BMI-for-age growth charts issued by the Centers for Disease Control and Prevention. A child is classified as obese if the BMI percentile was greater than or equal to 95. The average BMI (obesity prevalence) among 5th and 8th graders was 20.4 (20%) and 22.9 (18%), respectively. These figures compare well to obesity rates among 6- to 11-year-olds from the 2007-2008 National Health and Nutrition Examination Survey (Ogden et al. 2010).

Diet: In the 5th and 8th grades only, dietary intake was collected via the food consumption questionnaire. The first set of dietary measures consists of indicator variables capturing whether the child purchased sweets, salty snacks, and sweetened beverages (hereafter, "soda") at school during the previous week. The ECLS-K also asked children about the frequency of *overall* consumption of specific foods during the past 7 days including certain vegetables, fruit, milk, soda, and fast food. Because of the skewed responses, we create indicator variables for whether the child ate fruits at least once per day, ate vegetables at least once per day, and drank at least 1 glass of milk per day. These thresholds are lower than the recommended daily servings in the USDA's Dietary Guidelines (e.g. at least 3 servings each of fruits and vegetables daily), but we report these because the proportion of children complying with the recommended levels is low - only 15% (10%) of 5th (8th) graders in this sample ate 3 or more servings each of fruits and vegetables daily. We also create indicator variables for whether the child ate any fast food during the week and drank soda at least once a day. Findings from models with alternate thresholds are summarized briefly in the results.

Physical Activity: Days per week that the child did at least 20 minutes of vigorous exercise was reported by the parent in 5th grade and the child in 8th grade. Given that vigorous activity is recommended for children on most days of the week, our indicator variable measures whether the parent or child reported at least 5 days per week of such activity. In 5th grade, parents also reported whether the

children received regular exercise from community organizations during the past year such as public parks or recreation centers, places of worship, YMCA/YWCA or other similar organizations.

Sedentary Behavior: Usual number of hours of television viewing per week was reported by the parent in 5th grade and the child in 8th grade. In the 8th grade, children also reported usual hours spent on the Internet and video games separately. Consistent with the American Academy of Pediatrics recommendations for children's screen time, we create indicator variables for whether the child spent 2 or more hours per day on these activities.

Supervision: We examine two sets of variables that speak to supervision of children's diets and of children generally. First, we examine parent reports of whether the family eats breakfast and dinner together at least three times per week (dichotomized from continuous measure) and whether the child usually eats a school lunch or school breakfast. Then, we examine supervision more generally: parents reported the number of hours per week the child takes care of himself/herself in the 5th grade and the number of days per week that the child had adult supervision after school in the 8th grade. We create indicator variables to capture whether the child takes care of himself at least one hour per week in 5th grade and whether the child had at least one day per week without supervision in 8th grade.

Maternal work: Usual hours worked per week were reported by the parent (predominantly, the mother) in each wave. Average work hours during the period from Kindergarten through 5th grade and from Kindergarten through 8th grade were computed if available in at least two waves. The mean and median work hours between K-5 were 25.4 and 28, respectively. The mean (25.8) and median (28.25) were slightly higher over the K-8 period. Approximately 14% and 11% of children had mothers who did not work outside the home during 5th and 8th grades, respectively.

Covariates: We control for several child, family and contextual factors that are correlated with maternal work and children's BMI including the child's gender, race-ethnicity, age in months, birth

weight, disability, child's health status, parent's health status, mother's education, single parent, number of siblings, percent minority in school (proxy for school environment), and rural/urban indicators. Missing data for each covariate was replaced with its mean and mode for continuous and categorical variables, respectively, and a variable-specific missing data flag was included in the regressions. Detailed household income categories are included in some specifications. State-level measures of adult obesity prevalence and breastfeeding laws are included in the IV specifications to control for state-specific heterogeneity. To examine the effects by SES, we use the ECLS-K's SES measure constructed based on father's and mother's education and occupation and on household income. Each component of the SES measure was converted to a z-score with mean 0 and then averaged to create the SES composite measure. Families were categorized as "High SES" if they were in the top two quintiles of the composite measure and "Low SES" otherwise.

Our analysis sample consists of children with at least two waves of maternal work hours during the relevant period (e.g. K-5 or K-8) and at least one outcome variable in 5^{th} or 8^{th} grade.

5. Results

5.1. Graphical Results

To examine the relationship non-parametrically, we first plot the mean pBMI in 5^{th} and 8^{th} grades by average maternal work hours. For 5^{th} and 8^{th} grades, the mean pBMI decreases as maternal work hours increase from zero to very low intensity hours ($p<0.05$ and $p=0.052$, respectively), but increases steadily thereafter as maternal work hours increase. The corresponding graphs for obesity prevalence look similar (not shown). Figures 1 and 2 also plot the same relationship after adjusting for observed covariates excluding household income. The drop in mean pBMI from zero hours to 1-10 hours per week is now statistically insignificant and the relationship between maternal work hours and pBMI now

appears mostly linear. We also estimate adjusted OLS models that include linear and quadratic terms for continuous average maternal work hours and found that the quadratic term was not significant.

5.2. BMI and Obesity

Table 2 reports the estimated coefficient on average maternal work hours from OLS, school fixed effects and IV models for 5th graders and 8th graders.

Estimates in Row 1 show the unadjusted bivariate association between maternal work hours and child's pBMI for 5th and 8th grades: 20 additional work hours per week are associated with 2.3 and 2.4 percentile points higher BMI (3.5 and 3.6%) in the 5th and 8th grades, respectively. Controlling for basic child, family, and contextual variables described above including child's gender, race-ethnicity, age in months, birth weight, mother's education, single parent household, number of siblings, percent minority in school, and urbanicity does not change the coefficients (Row 2) (see Appendix A for full regression results).

The next three models add various sets of covariates to address potential omitted variable bias. In Row 3, we add parent-reported health status of the child, health status of the parent, and child's disability status. The lack of any significant change in the coefficient on maternal work suggests these factors do not explain any of the relationship between maternal work and child BMI. In Row 4, we add controls for detailed household income categories, which allow insight into the time versus income effects. The point estimates increase by about 10% but are not statistically different, which suggests that the time effect dominates. However, we caution that we cannot differentiate contributions from mother's and father's work. Finally, Row 5 adds indicators for father's work status (i.e. not working, working part-time, working full-time, and no father in the household) to address concerns that fathers may offset some of the effects of maternal work hours. Consistent with recent evidence (Ziol-Guest et

al, 2013), we find no evidence that the fathers' status explains the relationship between maternal work and child BMI. In additional models, we control for father's work hours and family structure, but find no significant change in the coefficient on maternal work (see Appendix B).

The next two rows explore whether unobserved heterogeneity may bias our estimates. Adding school fixed effects controls for unobserved differences across schools in children's background characteristics (e.g. parent involvement) as well as time-invariant policy differences (whether at the school or higher level), but does not change the coefficients noticeably (Row 6). In Row 7, we utilize an IV specification to identify plausibly exogenous variation in maternal work using state-level variation in labor market conditions. The first-stage generates a large joint F-statistic suggesting that the median state-level unemployment rate and average weekly wage of private non-agricultural workers are strong predictors of maternal work hours (see Appendix C). The relationship is much stronger for 5th (F-statistic>35) versus 8th grade (F-statistic>14) perhaps because employment is more responsive to economic conditions when children are younger. Overidentification tests cannot reject the null that the instruments are uncorrelated with the errors. Despite the strength of the instruments, the coefficients on maternal work from the second stage have relatively large standard errors. As a result, even though the point estimates are somewhat larger than the OLS estimates, the coefficients are no longer statistically significant. Given the large standard errors, a Hausman test cannot reject the consistency of the OLS estimates.

Finally, we also estimated specifications with raw BMI and an obesity indicator as dependent variables. These results indicate a strong positive association between maternal work hours and raw BMI that is similar in the 5th and 8th grades (Panel B Table 2). For the obesity indicator, the coefficient is also positive and significant, but varies with age (Panel C Table 2): a 20 hour increase in maternal

work hours is associated with a 2.2 percentage points (11%) increase in the likelihood of obesity in the 5th grade, but only a 1.2 percentage point (7%) increase in 8th grade.

These results suggest a remarkably stable positive relationship between average maternal work hours and children's BMI and obesity despite the addition of a host of health and socioeconomic controls for children, parents and families, some rarely available in traditional datasets.

Next, we estimate our preferred covariate-adjusted OLS model (Model 2) separately for high- and low-SES children (Table 3 Row 1). Our results confirm that the magnitude of the association is larger among high-SES children, where an additional 20 hours increases pBMI by 2.9 percentile points (5%) and increases the likelihood of obesity by 2.8 percentage points (19%) in the 5th grade (Columns 2 and 5). Among low-SES children, the effect is only half as large for pBMI and not significant for obesity (Columns 3 and 6). For both low-and high-SES, the estimates are very similar across 5th and 8th graders for pBMI. But for the obesity indicator, the association is only half as large for high-SES children in the 8th grade versus 5th grade and not at all significant for low-SES children.

5.3. Diet and Activity Behaviors

The results thus far suggest that greater maternal work hours may contribute to energy imbalance among children. In this section, we examine how maternal work hours are related to energy intake and expenditure separately. Figure 3 plots the estimated effect sizes and confidence intervals for 20 additional hours of maternal work on children's diet and activity behaviors in each grade. These effects are based on coefficients on maternal work hours in covariate-adjusted OLS models. Detailed estimates by SES are provided in Appendix D.

Higher maternal work hours are associated with significant reductions in the overall consumption of healthy foods in 5th and 8th grade. Figure 3 shows that 20 additional hours of work is associated with a statistically significant decrease in the likelihood of consuming fruits and vegetables at least once a day and consuming at least 1 glass of milk per day. For example, the likelihood of consuming fruits at least one time per day decreases by 1.4 (3.6%) and 1.6 (4%) percentage points. The estimated negative associations with consuming fruits, vegetables and milk are generally larger among the high-SES group. We also estimated models using alternate thresholds for fruit and vegetable consumption (4 or more times per week, at least twice a day) and found similar results (not shown).

Overall consumption of unhealthy foods also increases significantly with maternal work hours: a 20-hour increase in maternal work increases the likelihood of eating fast food at least once per week by 2.4 percentage points (3.3%) among 5th graders and 2.7 (4%) among 8th graders. Models that examined the likelihood of eating fast food at least 4 times per week (about 21% of 5th and 15% of 8th graders) yielded similar results (not shown). Because only a very small fraction of children (5% of 5th and 2% of 8th graders) ate fast food at least once per day, we did not estimate models for this threshold. An additional twenty hours of maternal work is also associated with a 2.0 percentage point (7%) increase in the likelihood of consuming soda at least once a day in 5th grade and a 1.6 percentage points (6%) in 8th grade. In alternate specifications, we estimated models of consuming *any* soda during the week and found increases significant only among 8th graders suggesting potential differences in extensive versus intensive margins as children age (not shown). The estimated effects for fast food and soda are larger among the high-SES group.

The next set of dietary variables provides insight into how some of these changes might be occurring. We examine junk food purchases at school among the sub-sample with availability at school. Eighth graders whose mothers worked an additional 20 hours per week are significantly more likely to

purchase sweets and soda at school. We do not observe significant associations during 5th grade, which is not surprising given that younger children have fewer discretionary resources (see Datar and Nicosia 2012b).

Unlike the results for diet, which consistently point towards adverse effects on children whose mothers work more, the results for physical activity are mixed. On the one hand, an additional 20 hours per week increases the likelihood of at least 5 days per week of vigorous physical activity by 1.6 (4%) and 1 (2%) percentage point(s) in 5th and 8th grades, respectively. On the other hand, there is also a significant increase in sedentary behaviors: these 5th and 8th graders are 3.9 and 3.0 percentage points (8 and 4%) more likely to watch 2 or more hours of TV per day, respectively. For 8th graders, we also estimate an increase in the likelihood of 2 or more hours of Internet and video games per day significant only at the 10% level. However, models that estimate the continuous measures of hours per week of Internet and videogame use (not shown) indicate that 20 additional maternal work hours are significantly associated with 0.74 additional hours per week of Internet use in 8th grade, but are not significantly associated with videogame use. The results by SES again show stronger associations among high-SES children.

These findings may seem somewhat contradictory in that children whose mothers work more engage in more physical activity and more sedentary behaviors. Part of the story may be the location or type of activity. Our conceptual model noted that children may be more sedentary when less supervised. But these families may also have the financial resources to enroll their children in sports programs and related activities (i.e. income effect). For the 5th grade only, we can examine whether the child received regular exercise through a community organization and find significantly higher likelihood among children whose mothers work more.

We have organized our analysis thus far around the energy balance equation, but it is clear from the conceptual model that supervision is likely to play a role. The ECLS-K provides measures of indirect and direct supervision that allow some insight into this issue (Figure 4). More work hours are associated with a significant reduction in the likelihood that the family eats breakfast and dinner together at least thrice per week in both grades. Models that estimate a continuous measure of the number of days the family eats together and models that use alternate thresholds (at least 4, 5 or 6 times per week) yield similar results (not shown). This interesting finding suggests less or lower-quality supervision of children's diet. The figure also shows a significant increase in school lunch participation consistent with time constraints on mothers' ability to prepare brownbag meals in both grades (see also Datar and Nicosia, 2012a). The relatively large associations are notable given that school lunch participation (unlike school breakfast) has been linked to obesity. While interesting, these findings are at best indirect measures of supervision and speak only to energy intake. Fortunately, the ECLS-K also provides an opportunity for direct insight into this overarching concern. The measures of supervision differed in 5th versus 8th grades, but consistently support the hypothesis of reduced supervision: children whose mothers work 20 additional hours per week are 4.4 percentage points (37%) more likely to care for themselves at least one hour per week during 5th grade and are 5.2 percentage points (32%) more likely to have at least one day unsupervised by an adult during 8th grade. Continuous specifications of these supervision measures yielded similar results (not shown). Results for both supervision measures indicate stronger associations for high-SES children.

Finally, we also estimated child fixed-effects models for pBMI, diet, and activity during 5th and 8th grade. These estimates were largely insignificant, potentially due to low variation in mother's work between 5th and 8th grades (see Appendix E)

5.4. How much do the diet and activity measures explain?

A natural next step would consider how much of the relationship between maternal work hours and child BMI is explained by the diet, physical activity and supervision measures. If we control for the contemporaneous variables from Figures 3 and 4, we reduce the estimated coefficient on maternal work by up to 16% in 5th and 20% in 8th grade. Given that diet and activity are the proximate causes of obesity, it may initially seem surprising that our measures do not explain more of the relationship. However, we observe only a limited set of contemporaneous behaviors, whereas BMI is likely influenced by the accumulation of all contemporaneous behaviors plus all past behaviors (e.g. habit formation, weight accumulation). Even with this unique and informative dataset, which provides tremendous insight into intake, expenditure and supervision, there are still aspects of the relationship between maternal work and child BMI that require additional research.

6. Conclusions

Our results confirm that maternal work hours are positively associated with children's BMI and obesity, especially among high-SES families. The estimates suggest that 20 additional hours per week of maternal work, on average, during elementary school years is associated with 2.3 percentile points (3.5%) higher pBMI and a 2.2 percentage point (11%) increase in the likelihood of obesity by the end of 5th grade. The results are similar for pBMI in the 8th grade, but smaller for obesity. These estimates are comparable to prior studies (Anderson et al, 2003; Ruhm, 2008; Ziol-Guest et al, 2013) despite one important difference. Our findings are based on measurements of height and weight and therefore provide more accurate assessments unlikely to be affected by non-random reporting bias.

Our main contribution lies in the exploration of the mechanisms underlying this relationship, which has been a significant gap in the literature. Our paper is the first to provide a comprehensive picture of the likely drivers by exploring BMI, diet and activity for a single large national sample. As a result, these data allow us to link changes in BMI to the mechanisms underlying those changes for the

same children. Our data contain information on a wide range of dietary and activity measures including children's consumption of healthy and unhealthy food and beverage items, junk food purchases in school, and the frequency, location, and type of activity. The deterioration in children's diet appears to be an important mediator in the maternal work-childhood obesity link and is consistent with time-use and other studies (e.g. Cawley and Liu, 2012; Klesges et al. 1991). We find strong evidence that children whose mothers work more consume more soda and fast food and less fruits, vegetables, and milk. The findings for activity-related behaviors are somewhat mixed showing evidence of an increase in physical activity but also an increase in sedentary behaviors. These results are also consistent with empirical evidence that working mothers may have less time to supervise their children (Cawley and Liu 2012; Fertig et al. 2009).

The time constraint appears to dominate the income effect given the robust linear relationship between maternal work hours and BMI and the limited impact of controlling for household income. The time constraint means that working mothers may have less time to prepare healthy meals. Our finding that greater maternal work hours are associated with an increased likelihood of fast food consumption and school lunch participation supports this notion. Greater income may be yet another channel as children whose mothers work more are more likely to purchase junk foods at school. We also find indirect and direct support for the hypothesis that working mothers have less time to supervise their children, which creates opportunities for poor diet and activity choices. Children whose mothers work more spend more hours per week caring for themselves and are less likely to eat breakfast and dinner together with the family. Our results also suggest that father's work hours and family structure do not mediate the relationship between maternal work and child BMI. Finally, our results are also consistent with the literature's finding that the effects on BMI are stronger among high-SES children. We

contribute to that literature by showing that these children experience greater deterioration in their dietary behaviors and increases in sedentary behaviors when mothers work more hours.

The take-away from our study is not that childhood obesity can be addressed by reducing mothers' work hours. The increase in maternal labor supply over the past several decades is a result of complex socio-economic trends and is likely to have had wide-ranging beneficial and adverse impacts on children. Rather, our paper identifies one specific set of unintended consequences of such a major societal change. The implication of our findings is that there is a potential role for new and existing policies to mitigate some of these adverse impacts given that current levels of maternal labor supply will continue. For example, existing federal programs like the Child and Adult Care Food Programs and School Meal Programs may be existing policy vehicles that can help mitigate adverse impacts on children.

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Figure 1: BMI Percentile in 5th Grade by Average Maternal Work Hours

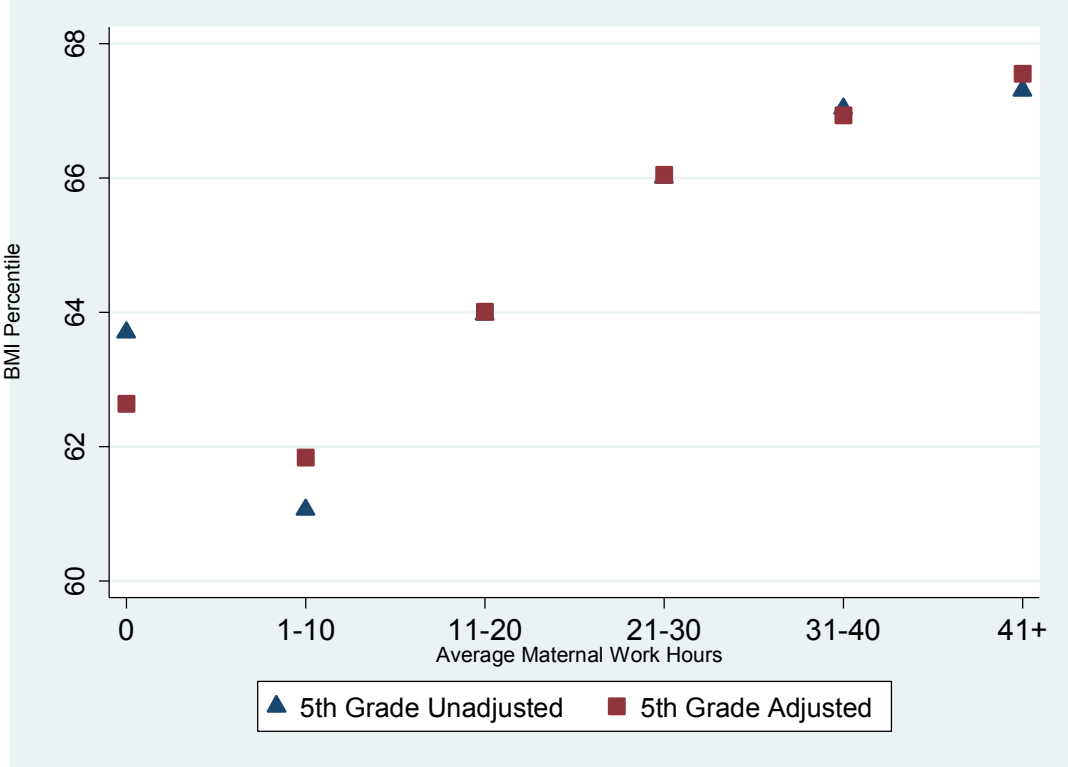


Figure 2: BMI Percentile in 8th Grade by Average Maternal Work Hours

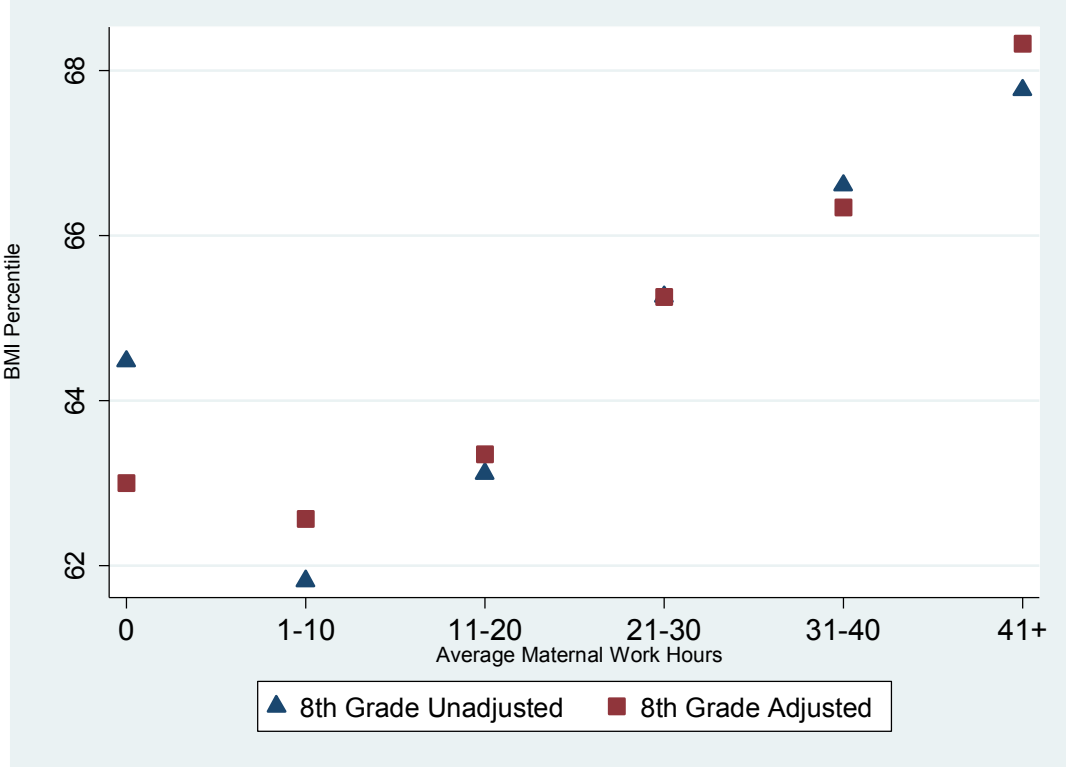
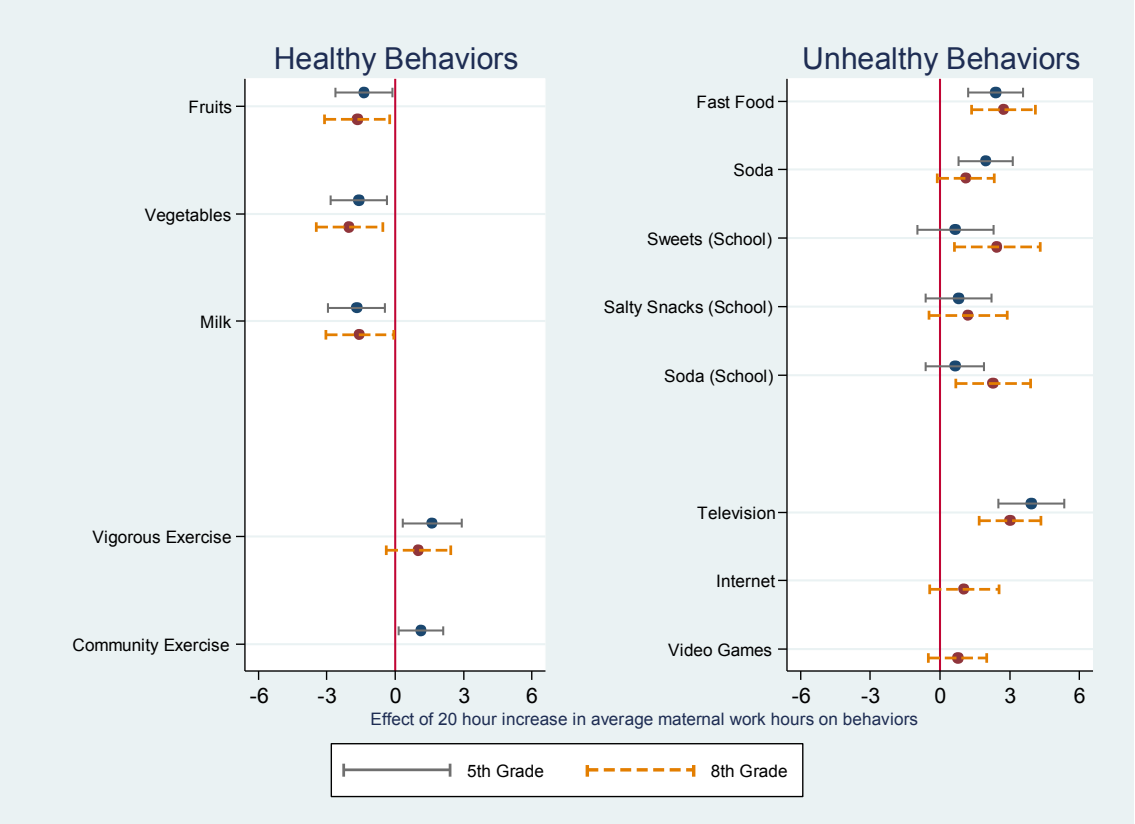
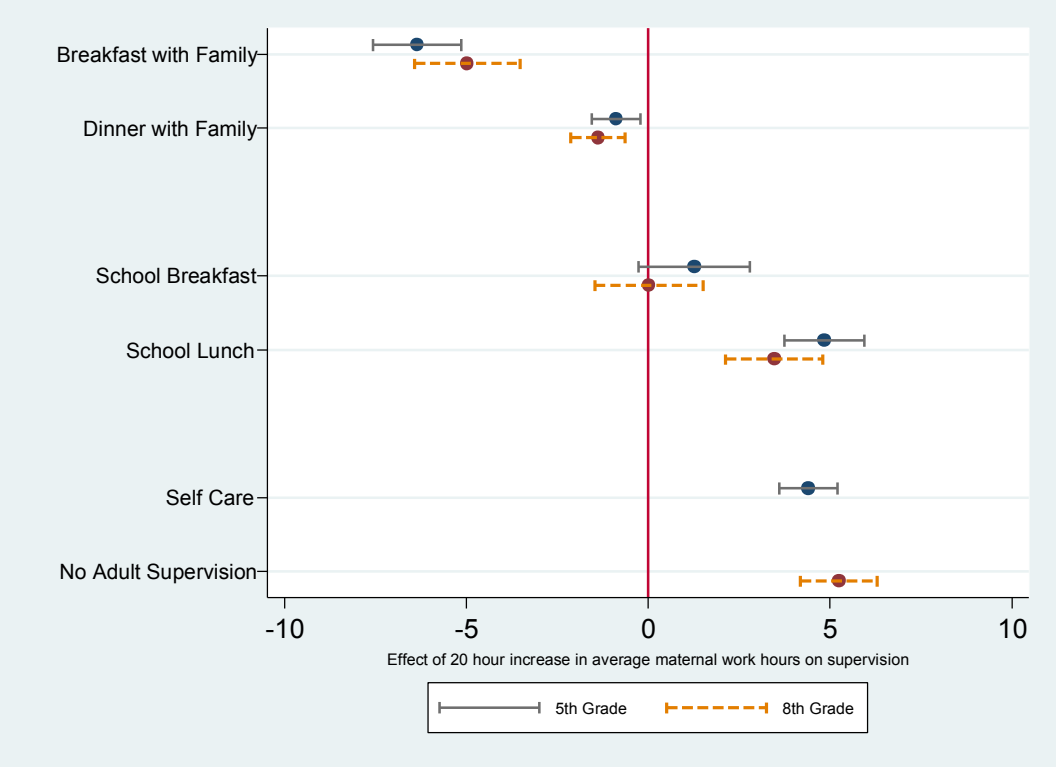


Figure 3: Relationship between maternal work hours and children's food and activity behaviors



Notes: All estimates are from OLS models that control for basic child, family and contextual variables. Estimates have been multiplied by 20 to reflect 20 hour increase in average maternal work hours and reflect percentage point changes. Error bars represent 95% confidence intervals.

Figure 4: Relationship between maternal work hours and supervision measures



Notes: All estimates are from OLS models that control for basic child, family and contextual variables. Estimates have been multiplied by 20 to reflect 20 hour increase in average maternal work hours and reflect percentage point changes. Error bars represent 95% confidence intervals.

Table 1: Descriptive Statistics of 5th Grade and 8th Grade Sample

	5th Grade	8th Grade
Outcomes	**% or Mean (SD)**	
BMI percentile	65.4 (29.9)	65.4 (28.6)
Obesity (%)	20.3	18.0
Dietary Behaviors		
Eat fast food meal at least 1 time per week (%)	71.4	69.5
Drink soda at least 1 time per day (%)	29.8	26.3
Drink at least 1 glass milk per day (%)	55.7	49.7
Eat fruits at least 1 time per day (%)	38.9	40.5
Eat vegetables at least 1 time per day (%)	53.7	56.0
Purchase salty snack at school at least 1 time per week (if available) (%)	22.2	31.9
Purchase sweet at school at least 1 time per week (if available) (%)	33.7	39.5
Purchase soda at school at least 1 time per week (if available) (%)	15.7	27.8
Physical Activity and Sedentary Behaviors		
Vigorous exercise at least 5 days per week	35.8	56.9
Child regularly got exercise through a community organization	82.0	NA
TV at least 2 hours per day	49.3	70.1
Internet at least 2 hours per day	NA	50.0
Video games at least 2 hours per day	NA	30.0
Supervision		
Eat breakfast as family at least 3 days per week	53.0	49.5
Eat dinner as family at least 3 days per week	91.8	92.4
Receives school breakfast	26.7	22.9
Receives school lunch	77.2	76.1
Take care of self (at least 1 hour per week)	12.0	NA
No adult supervision (at least 1 day per week)	NA	16.5
Sample Size	10,630	9.390

Table 2: Relationship between average maternal work hours and children's BMI and obesity

Model Description		Coefficient on Mother's Average Work Hours	
		5th Grade	8th Grade
(A) Dependent Variable: child pBMI			
1.	No covariates	0.113***	0.118***
		(0.018)	(0.020)
2.	Controls for basic child, family, contextual variables	0.115***	0.118***
		(0.020)	(0.022)
3.	Model (2) plus controls for child and parent health measures	0.118***	0.121***
		(0.020)	(0.023)
4.	Model (2) plus controls for household income categories	0.128***	0.131***
		(0.020)	(0.022)
5.	Model (2) plus controls for father's work status categories	0.115***	0.118***
		(0.020)	(0.022)
6.	Model (2) plus school fixed effects	0.116***	0.109***
		(0.023)	(0.026)
7.	Model (2) with IV (state unemployment rate and state wage) for maternal work plus controls for state adult obesity rate and state breastfeeding laws	0.194	0.263
		(0.274)	(0.345)
(B) Dependent Variable : raw BMI		0.018***	0.018***
		(0.003)	(0.004)
(C) Dependent Variable: binary indicator for obese status[a]		0.112***	0.061**
		(0.026)	(0.028)

Notes: Robust standard errors in parentheses. Sample sizes range from 9,310 – 9,940 for 5th grade and 7,230-8,580 for 8th grade. [a] Coefficients have been multiplied by 100, so they capture percentage point change in likelihood of obesity in response to one additional hour of work. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Table 3: Relationship between maternal work hours and children's BMI by socioeconomic status

	Coefficient on Mother's Average Work Hours					
	5th Grade			8th Grade		
	All	High SES	Low SES	All	High SES	Low SES
Dependent Variable	(1)	(2)	(3)	(4)	(5)	(6)
Child pBMI	0.115***	0.144***	0.075***	0.118***	0.153***	0.069**
	(0.020)	(0.029)	(0.028)	(0.022)	(0.033)	(0.032)
Child obesity[a]	0.112***	0.138***	0.062	0.061**	0.120***	-0.042
	(0.026)	(0.034)	(0.041)	(0.028)	(0.035)	(0.045)

Notes: Robust standard errors in parentheses. All estimates are from OLS models that control for basic child, family and contextual variables. [a] Coefficients have been multiplied by 100 to reflect percentage point changes. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Appendix A: Full OLS Regression Results

Dept Var: pBMI	5th Grade	8th Grade
Mother's average work hours	0.115*** (0.020)	0.118*** (0.022)
Male	2.694*** (0.617)	-1.876*** (0.620)
Child race/ethnicity (Ref: White)		
Black	7.180*** (1.214)	8.203*** (1.233)
Hispanic	7.275*** (1.034)	6.101*** (1.061)
Asian	-1.765 (0.262)	-0.841 (1.627)
Other	3.917** (1.572)	3.697** (1.559)
Age (in months)	-0.092 (0.070)	-0.009 (0.730)
Mother's education (Ref: less than high school)		
High School	-2.704** (1.150)	-4.477*** (1.382)
Some College	-5.163*** (1.168)	-5.988*** (1.370)
College	-8.685*** (1.241)	-10.873*** (1.427)
Urbanicity (Ref: Rural)		
Town	-2.425*** (0.921)	-3.236*** (0.980)
City	-4.428*** (0.977)	-3.103*** (1.040)
Percent minority in school (Ref: <10%)		
10% to 24%	-0.951 (0.968)	-1.820* (1.009)
25% to 49%	-0.883 (1.065)	-0.034 (1.065)
50% to 74%	1.025 (1.429)	1.782 (1.343)
75% or more	1.566 (1.160)	-0.090 (1.309)
Number of siblings	-0.831*** (0.287)	-0.385 (0.304)
Single parent	1.800** (0.815)	2.677*** (0.885)
Child birthweight (in pounds)	3.029*** (0.243)	2.745*** (0.251)
R^2	0.056	0.056
Number of observations	9500	8150

Notes: Robust standard errors in parentheses. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Appendix B: Associations between Child's BMI and Parental Work and Family Structure

Regression of 5th Grade pBMI on 5th Grade Covariates

Dept Var: pBMI 5th	Coef.	Robust Std. Err.	p-value
Mom avg hrs	0.123	0.020	0.000
Dad avg hrs	-0.015	0.021	0.461
Single parent family	0.942	1.021	0.356
No. of siblings	-1.202	0.292	0.000
No. of adults	2.313	0.457	0.000

Notes: Model includes the full set of covariates; R-squared=0.0636

Regression of 8th Grade pBMI on 8th Grade Covariates

Dept Var: pBMI 8th	Coef.	Robust Std. Err.	p-value
Mom avg hrs	0.128	0.023	0.000
Dad avg hrs	0.015	0.023	0.501
Single parent family	1.029	1.108	0.353
No. of siblings	-0.744	0.316	0.019
No. of adults	1.309	0 .487	0.007

Notes: Model includes the full set of covariates; R-squared=0.0648.

Appendix C: First stage estimates from IV regressions

	Dependent Variable: Average Maternal Work Hours	
	5th Grade	8th Grade
Male	0.297 (0.315)	0.112 (0.330)
Black	2.815*** (0.650)	3.462*** (0.674)
Hispanic	0.954* (0.543)	1.356** (0.566)
Asian	3.512*** (0.730)	4.502*** (0.802)
Other race	0.374 (0.782)	0.954 (0.807)
Age (months)	-0.025 (0.036)	-0.049 (0.038)
Mothers education		
HS	7.389*** (0.627)	7.237*** (0.732)
Some college	9.001***(0.613)	8.484*** (0.706)
College	9.882*** (0.644)	9.871*** (0.728)
Urbanicity		
City	-2.044***(0.479)	-2.327*** (0.511)
Town	-2.120***(0.465)	-2.528*** (0.480)
Number of siblings	-2.723*** (0.142)	-2.593*** (0.155)
Single parent	5.088*** (0.429)	4.555*** (0.468)
% minority students in school		
10% to less than 25%	0.117 (0.478)	0.302 (0.491)
25% to less than 50%	1.003* (0.507)	0.550 (0.522)
50% to less than 75%	3.097*** (0.660)	1.823*** (0.644)
75% or more	1.944*** (0.614)	0.226 (0.663)
Birth weight	0.262** (0.121)	0.427*** (0.127)
State adult obesity	0.091 (0.072)	0.215*** (0.081)
State breast feeding laws		
Employers provide break time and private space	-0.750 (0.484)	-0.624 (0.507)
Employers prohibited from discriminating	1.833** (0.372)	0.579 (0.929)
Breastfeeding permitted in any location	0.769** (0.372)	-0.194 (0.429)
Breastfeeding exempt from public indecency laws	-0.068 (0.383)	-0.822* (0.381)
Breastfeeding mothers exempt from jury duty	1.125* (0.610)	-0.251 (0.486)
Median State Unemployment rate	-1.693*** (0.265)	-1.115*** (0.307)
Median State Average Weekly Wage	-0.008*** (0.002)	-0.006*** (0.002)
First-stage F-Stat on Instruments	F=35.36; P<0.000	F=14.30; P<0.000
Hausman test statistic	0.111; P=0.739	0.171; P=0.679
Overidentification test	0.319; P=0.572	0.066; P=0.797

Notes: Robust standard errors in parentheses. * Significant at 10%, ** Significant at 5%, *** Significant at 1%.

Appendix D: Relationship between maternal work hours and children's dietary and activity behaviors, by socioeconomic status

	Coefficient on Mother's Average Work Hours					
	5th Grade			8th Grade		
Dependent Variable	All	High SES	Low SES	All	High SES	Low SES
Dietary Behaviors						
1. Fast food consumption (at least 1 meal per week)	0.120*** (0.030)	0.160*** (0.045)	0.082* (0.043)	0.137*** (0.035)	0.166*** (0.054)	0.085* (0.050)
2. Soda (at least once per day)	0.099*** (0.030)	0.135** (0.042)	0.059 (0.044)	0.055* (0.031)	0.146*** (0.044)	-0.035 (0.049)
3. Fruits (at least once per day)	-0.068** (0.032)	-0.103** (0.045)	-0.013 (0.047)	-0.083** (0.036)	-0141** (0.055)	-0.021 (0.054)
4. Vegetables (at least once per day)	-0.075** (0.032)	-0.060 (0.047)	-0.058 (0.046)	-0.100*** (0.037)	-0.178*** (0.055)	-0.031 (0.054)
5. Milk (at least 1 glass per day)	-0.085*** (0.032)	-0.102** (0.045)	-0.041 (0.048)	-0.078** (0.038)	-0.060 (0.057)	-0.031 (0.054)
6. Sweets at school (purchase at least 1 per week)	0.033 (.042)	0.046 (0.060)	0.020 (0.060)	0.123*** (0.047)	0.094 (0.065)	0.077 (0.072)
7. Salty snacks at school (purchase at least 1 per week)	0.040 (0.036)	0.036 (0.049)	0.038 (0.053)	0.061 (0.043)	-0.014 (0.064)	0.091 (0.060)
8. Soda at school (purchase at least 1 per week)	0.032 (0.032)	0.085** (0.040)	-0.009 (0.047)	0.114*** (0.041)	0.068 (0.054)	0.149** (0.064)
Physical Activity and Sedentary Behaviors						
9. Rigorous exercise (at least 5 days per week)	0.082** (0.033)	0.103** (0.046)	0.076 (0.046)	0.051 (0.036)	-0.030 (0.053)	0.122** (0.054)
10. Child regularly got exercise through community organization	0.057** (0.025)	0.102*** (0.039)	0.018 (0.031)	NA	NA	NA
11. TV (at least 2 hours per day)	0.196*** (0.036)	0.289*** (0.050)	0.062 (0.056)	0.151*** (0.034)	0.221*** (0.055)	0.088* (0.049)
12. Internet (at least 2 hours per day)	NA	NA	NA	0.052 (0.038)	0.097* (0.057)	0.006 (0.054)
13. Video games (at least 2 hours per day)	NA	NA	NA	0.038 (0.032)	0.096** (0.043)	-0.014 (0.051)
Supervision						
14. Eat breakfast with family (at least 3 days per week)	-0.318*** (0.031)	-0.365*** (0.043)	-0.230*** (0.048)	-0.249*** (0.037)	-0.261*** (0.052)	-0.223*** (0.053)
15. Eat dinner with family (at least 3 days per week)	-0.044** (0.017)	-0.040 (0.026)	-0.050* (0.026)	-0.069*** (0.019)	-0.078*** (0.028)	-0.064** (0.026)
16. Receives school lunch	0.242*** (0.028)	0.387*** (0.046)	0.091*** (0.031)	0.173*** (0.034)	0.247*** (0.055)	0.070* (0.037)
17. Receives school breakfast	0.063 (0.039)	0.249*** (0.045)	-0.076 (0.050)	0.001 (0.038)	0.162*** (0.044)	-0.103* (0.053)
18. Take care of self (at least 1 hour per week)	0.222*** (0.020)	0.248*** (0.030)	0.190*** (0.027)	NA	NA	NA
19. No Adult supervision (at least 1 day per week)	NA	NA	NA	0.262*** (0.027)	0.336*** (0.042)	0.185*** (0.035)

Notes: Robust standard errors in parentheses. Each coefficient estimate comes from a separate regression. * Significant at 10%, ** Significant at 5%, *** Significant at 1%

Appendix E: Child Fixed-Effect Regressions of pBMI, Diet, and Activity on Contemporaneous Maternal Work Hours

Dept. Var	Mom Hrs Coeff.	Robust Std. Err	P-value
pBMI	-0.012	0.013	0.348
Obese	-0.023	0.024	0.321
Television	0.071	0.051	0.168
Vigorous Exercise	0.078	0.050	0.117
Soda	0.106	0.044	0.015
Milk	-0.017	0.046	0.707
Fast Food	0.005	0.045	0.918
Vegetables	-0.015	0.047	0.742
Fruits	-0.011	0.048	0.824
Sweets (school)	-0.066	0.072	0.358
Salty Snacks (school)	0.026	0.067	0.692
Soda (school)	0.049	0.062	0.430

Note: Each line represents a separate regression; model include the full set of time-varying covariates