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The connection between maternal employment and childhood obesity: inspecting the mechanisms

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Abstract This paper investigates the channels through which maternal employment affects childhood obesity. We use time diaries and interview responses from the Child Development Supplement of the Panel Study of Income Dynamics which combines information on children's time allocation, children's BMI, and mother's labor force participation. We find some evidence that supervision and nutrition play significant but small roles in the relationship between maternal employment and childhood obesity. Although the difference in the effect of maternal employment varies by mother's education, we find few differences in the mechanisms by mother's education.

Keywords Maternal employment · Childhood obesity · Time use data

JEL Classicification I12 · J13 · J22

1 Introduction

Over the past several decades, obesity has swept across the US and other industrialized countries, affecting all age groups. The fraction of overweight children between the ages of 6 and 11 increased from 4% in the 1960s to 19% by 2003–2004.

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The problem of childhood obesity has already triggered a federal policy response—a recent law (Public Law 108–265) required schools to have a local wellness program in place starting by the beginning of school year 2006–2007. The program must address both nutritional and physical activity goals. The immediate cause of the increase in obesity is clear: calories taken in persistently exceed calories burned. The more fundamental reasons are less clear: why would so many people in these particular years choose to systematically take in more calories than they expend? According to Cutler et al. (2003) and Philipson and Posner (2003), technological progress is responsible for cheaper fattening foods and a more sedentary lifestyle, while Chou et al. (2004) claim that a decrease in smoking and an increase in the availability of restaurants, especially fast food restaurants, are responsible.

Any potential explanation for the phenomenal increase in *childhood* obesity must also involve changes in parental behavior, lifestyle, or attitudes (Patrick and Nicklas 2005; Golan and Crow 2004; Ebbling et al. 2002). One important change over this period that has touched family life in many ways is the increase in employment among mothers. Recently several papers have documented a positive relationship between maternal employment and the bodyweight of her children (Anderson et al. 2003; Lamerz et al. 2005; Classen and Hokayem 2005; Liu et al. 2005; Phipps et al. 2006; Courtemanche 2007; Cawley and Liu 2007; Chia 2008; Ruhm 2008). Interestingly, this connection seems to be especially pronounced for more educated, well off, white families. Taking the connection between mothers' employment and childhood obesity as given, this paper aims to identify the mechanisms by which mothers' labor supply affects children's weight, and to explore why the effect of maternal employment is more pronounced for children from higher socioeconomic backgrounds. In addition, following the previous literature we concentrate our analysis on the intensive margin (hours of work) and not the extensive margin (labor force participation).

Specifically, our empirical strategy is to estimate the effect of maternal work hours on child's weight controlling for a wide variety of potential channels. We obtain data on the potential channels through time diaries of the child's day. Our 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 maternal work hours on child's weight. Because the relationships between a mother's work hours and her child's activities, and between the child's activities and the child's weight status, may be due not only to a direct causal link, but also to some unobservable characteristic of the family or mother which results in these correlations, we must interpret the findings from this approach as highly suggestive and not necessarily causal. However, empirical techniques like instrumental variables or fixed effects, which may reduce some of this endogeneity, are not possible because of the small sample size available with the data used here.

The overarching theoretical principle guiding the empirical investigation is the concept of a health production function for children, where child's health (inversely measured by obesity) is the output and mother's time at home with the child is the input. Given a low level of maternal education, the child's health production function is depicted by locus L in Fig. 1. Each additional hour of mother's time spent with the child increases the child's health but there are diminishing returns to

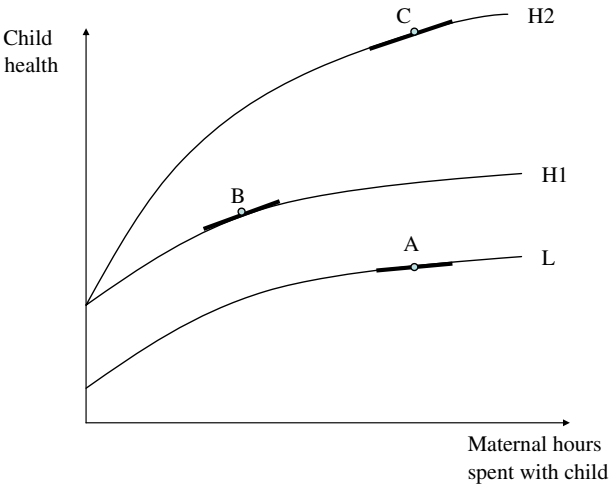

Fig. 1 Maternal Education and Child's Health Production. *Notes*: Line *L* represents the production function of child health for less educated mothers, while line *H1* and *H2* represent two possible production functions for more educated mothers of different levels of efficiency

mother's time. The production function for a mother with a high level of education would lie above L because mothers with more schooling have superior information which allows the same input level to produce a better health outcome. However, it is not clear from economic theory whether the slope of the production function is affected by maternal education. Thus, the production function for a more educated mother could look like H1, with the same shape as L, or could look like H2, where the slope is steeper at every input level. The steeper slope implies that children benefit more in terms of health from an additional hour of their mother's time if she is more educated than if she is not, at every input level. Klohe-Lehman et al. (2006) and Wardle et al. (2000) document that nutrition knowledge is an important determinant of dietary intake even after controlling for socio-economic characteristics such as income, race, schooling. The findings in Variyam et al. (1999) that nutrition knowledge of mothers gleaned from questionnaires is associated with substantially better diet of children is consistent with our specification of how the health production functions may vary by mother's educational status and health knowledge.

Thus, we might expect the effect of mothers' employment on children's health, represented by the slope of the production function, to be different by mother's education for two reasons. First, mother's education may be related to the average input level. If more educated mothers work more hours on average, then even if the production functions have the same shape—as depicted by L and H1 in Fig. 1, more educated mothers are going to be on a steeper portion of the curve (point B) than the average less educated mother (point A). Second, mother's education may increase the slope of the production function, as depicted by H2, such that given the same input level, more educated mothers are on a steeper slope (point C) than less educated mothers (point A). In either case, we would observe that an additional hour

worked by a more educated mother will have a more detrimental effect on her child's health than an additional hour worked by a less educated mother.

Economic theory suggests that there are various channels through which maternal employment can influence childhood bodyweight. First, a working mother has less time available to cook and prepare meals. Working mothers may decide to cook fewer meals at home, opting instead for more restaurant meals, or preparing more ready to eat meals, take out or delivered meals. Restaurant meals, especially from fast food restaurants, and ready to eat meals are generally more densely packed with calories than meals prepared at home. In addition, children of mothers with less time to devote to household activities might skip some meals, e.g. breakfast. There is ample evidence (Stauton and Keast 1989; Morgan et al. 1986) that skipping breakfast is associated with overall higher calorie consumption. Moreover, a low meal frequency may lead to higher concentrations of 24 h insulin, which, in turn, can lead to increased fat deposition and higher body weight (see Ma et al. 2003). This channel suggests that higher maternal employment results in higher children's bodyweight.

Similarly, working mothers may have less time and energy available to supervise and participate in their children's activities. This may mean that children are more autonomous in choosing their own activities or that the children spend more time in the care of others—either in school or in child care. Since parents presumably care more about the future health of their children than do other caretakers or children themselves, this may result in more time in front of the television, less time in outside activities, and a greater quantity of unhealthy snacks. Anderson and Butcher (2006) argue that schools "have given students greater access to 'junk' foods and soda pop," and find that access to junk food in schools increases students' weight. However, using time use data, Bianchi (2000) finds that working mothers do not sacrifice time with their children but instead reduce their leisure time. In addition, other caretakers may be able to offer a more structured routine involving physical activities with other children and healthier snacks than parents might provide. For example, von Hippel et al. (2007) show that children gain weight during summer months more rapidly than during the school year. Thus, it is not clear a priori whether this channel suggests that more maternal working hours results in higher or lower child weight.

Third, increased hours worked by the mother results in higher household income. There is a large empirical literature which finds a negative relationship between obesity and socioeconomic status (e.g. Gordon-Larsen et al. 2003; Zhang and Wang 2004a, b). The reasons for this linkage are debatable. Higher disposable income may allow households to provide better quality food or enroll children in organized activities which would reduce children's weight. However, the linkage might be entirely due to selection; people with low discount rates invest in education, which brings them higher earnings, and invest in their health, which keeps their weight in the normal range. While income in general is believed to have a negative effect on obesity, higher household income results in more restaurant meals (if restaurant meals are normal goods) which could result in a higher bodyweight for reasons elaborated above. Thus, economic theory does not unambiguously predict whether this channel results in higher or lower bodyweight for children.

Finally, we expect that currently working mothers returned to work sooner after birth and thus were less able to breastfeed or stopped breastfeeding earlier. There is

evidence that bottle fed infants are more likely to be overweight as children and adults than breastfed infants (Lucas et al. 1980, 1981). Thus, it may be that a mother's average work hours are correlated with her child's BMI because they are a good indicator of the probability that her child was bottle fed.

To quantify the importance of the various channels through which maternal employment may affect children's body weight, we use the Child Development Supplement (CDS) of the Panel Study of Income Dynamics (PSID). The CDS is well suited for this analysis because it includes the height and weight of the child, time diaries of the child's activities during one weekday and one weekend day, and a great deal of information about the child's household through the linkage with the main PSID survey.

The data and sample are described in Sect. 2. There, using our dataset, we also replicate the empirical finding that maternal employment has a positive and significant effect on children's BMI which is stronger for more educated mothers. In Sect. 3, we detail our empirical strategy, which involves estimating a series of equations to determine whether a variety of potential mediators significantly change the estimated effect of maternal employment on children's BMI. The results are presented in Sect. 4. We find that TV watching and the number of meals eaten in a day appear to play significant but small roles in the relationship between maternal employment and children's weight. In addition, we find only one difference in the potential channels by the mother's educational status. Among mothers with no more than a high school diploma, maternal employment significantly increases the amount of time a child spends in school, which in turn, significantly *decreases* a child's BMI. For more educated mothers, it is child care that increases when mothers work more, but the effect on children's BMI is similarly negative. While we don't claim that our findings are causal we see them as thought provoking and suggesting directions for further research. Finally, we offer a summary and conclusions in Sect. 5.

2 The data

The data used in this study come from the CDS of the PSID. The PSID has followed approximately 5,000 families since 1968. This original sample includes an equal probability, nationally representative sample of about 3,000 households called the Survey Research Center (SRC) sample, and a sample of about 2,000 low-income families called the Survey of Economic Opportunity (SEO) sample. Over time, the study has added the 'split-off' households of children and other members of the original PSID households after they leave and start their own families, such that in 1996 there were over 8,700 families involved in the survey.

Currently, the CDS consists of two waves. The first wave involves a sample of approximately 3,500 children under the age of 13 who are members of PSID families in 1997. Because the sample of children is drawn from both the SRC and the SEO samples, the children's sample has unequal selection probabilities. The second wave involves re-interviewing about 2,900 children in 2002, when they were between the ages of 5 and 17. In this analysis, we use approximately 3,400 observations of 2,500 children from 1,100 PSID families. We have two observations

on many children and there are some siblings as the CDS included at most two children from a family. Of the approximately 3,000 observations (3,500 + 2,900 − 3,400 = 3,000) that we omit, 700 are of children under the age of 3 at the first interview; the remainder are omitted because of missing information on height, weight, or mother's work hours, or there was no complete time diary for the child in a given wave.[1] Because we omit a large fraction of the total observations available in the CDS due to these sample restrictions, we provide comparison statistics on the sample without these restrictions in Appendix Table 8 to demonstrate that the sample used in this analysis is not selected on any important observable characteristics.

Table 1 presents some descriptive statistics by mother's education (Appendix Table 8 presents statistics on the full CDS sample for comparison). The primary variables of interest in this analysis are the child's percentile BMI and whether the child is overweight. We do not use the BMI scale itself because its connection to overweight is highly dependent on the child's age and sex, unlike for adults. BMI is calculated as weight in kilograms divided by height in meters squared (kg/m^2). The Centers for Disease Control (CDC) has produced a chart of percentiles describing the BMI distribution by the age (in months) and sex of children based on early waves (from the 1960s, 1970s, and 1980s) of the nationally representative National Health and Nutrition Examination Survey (NHANES). Thus, we use these percentiles as our continuous dependent variable instead of the actual BMI because we believe that it may better capture the child's weight status. Because we are most interested in changes in weight near the overweight threshold, following the CDC, we define children to be overweight if the child's BMI is above the 95th percentile for their age and sex, and at risk of being overweight if their BMI is between the 85th and 95th percentiles, and create limited dependent variables with these cutoffs. Because of the growing numbers of overweight children and because this sample includes an oversample of black children, who have a higher rate of overweight than the national average, substantially more than 5% of children are classified as overweight in our sample measured in 1997 and 2002: the percentage of children overweight is 23.4 among less educated mothers and 20.3 among more educated mothers. More strikingly, 39.4% of children with less educated mothers and 35.0% of children with more educated mothers are either overweight or at risk of being overweight. Finally, the children's average percentile in the CDC's BMI distribution ranges between 64 and 67%, which again reflects the high proportion of overweight children in this sample.

The other key variable in this study is the hours per week worked by the mother. For this measure, we average the mothers' weekly working hours for a representative week over the 2 years prior to the interview. If the mother does not work, zero hours are assigned. On average, less educated mothers worked about 26 h per week while more educated mothers worked closer to 28 h per week on average. The fraction of mothers who did not work at all during these 2 years is almost 21% for less educated mothers and about 13% for more educated mothers.

[1] In addition, we omitted 132 observations for children with physical measures that would put them in the first tenth of the first percentile of the CDC Growth charts.

Table 1 Descriptive statistics by mother's education

	Mother's Ed ≤ 12 years		Mother's Ed > 12 years	
	Mean	*N*	Mean	*N*
Overweight (BMI > 95th percentile for age and sex)	23.4%	1,734	20.3%	1,539
Risk of overweight (85th percentile–95th percentile)	16.0%	1,734	14.7%	1,539
BMI of children	20.59	1,734	19.85	1,539
BMI percentile of children[a]	66.5	1,734	64.3	1,539
Hours per week worked by mother in last 2 years (if any)	25.88	1,377	27.88	1,342
Hours per week worked by mother over child's life (if any)	17.27	1,519	20.53	1,439
Mother didn't work in last 2 years	20.6%	1,734	12.8%	1,539
Mother never worked during child's life	12.4%	1,734	6.5%	1,539
Age of child	9.82	1,734	9.52	1,539
Black	43.9%	1,732	30.4%	1,534
Hispanic	10.9%	1,732	2.2%	1,534
Female	51.2%	1,734	48.0%	1,539
First born child	43.4%	1,734	58.8%	1,539
Birth weight (pounds)	7.19	1,714	7.47	1,525
Number of children in household	2.41	1,734	2.23	1,539
Age of mother at child's birth	25.52	1,622	28.72	1,528
Education of mother in 1997 (years)	10.53	1,734	14.81	1,539
Mother is obese (BMI > 30)	27.3%	1,690	18.9%	1,518
Father is obese (BMI > 30)	23.8%	1,397	18.3%	1,386
Parents always married over child's life	47.2%	1,734	70.0%	1,539
Annual labor income over child's life ('000)	$26.30	1,390	$52.16	1,363
Hours per week worked by father over child's life	34.38	1,384	39.21	1,341
Mother received foodstamps in last year	19.8%	1,676	5.4%	1,498
Northeast	10.5%	1,734	18.7%	1,536
North Central	22.1%	1,734	24.5%	1,536
South	45.7%	1,734	38.5%	1,536
West	21.7%	1,734	18.3%	1,536
Urban	51.8%	1,547	57.5%	1,444

[a] Percentiles based on 2000 CDC Growth Charts by gender and child's age in months

We use only the last 2 years because most of the channels investigated here would only be affected by recent employment patterns. However, because a high BMI is typically the result of persistent and long-run over-consumption of calories, we also examine the effect of mother's hours averaged over the child's entire lifetime (which ranges between 3 and 17 years). Over the longer period, mothers' average hours are about 8 h lower and fewer mothers have never worked during this child's life. Again, the hours and labor force participation rates are higher for the more educated mothers.

The remainder of Table 1 describes the sample with a list of our main demographic controls. On average, children were just under 10 years old. Because the CDS draws from both the SRC and the SEO samples, there are a large proportion of black families—44% of children with less educated mothers are black and 30% of children with more educated mothers are black. On the other hand, the Hispanic sample is disproportionately small because of the design of the PSID. The Latino sample added to the PSID in 1990 was dropped in 1995 and a new immigrant sample was added in 1997. The CDS includes about 250 immigrant children from this new sample, some of whom are Hispanic.

Of particular importance to this analysis, we can calculate the mother's BMI from the main household interview which asks the height and weight of the head of the household and the spouse. These questions are only available in the 1986, 1999, 2001, and 2003 interviews. We use the mother's BMI in 1999 for the 1997 CDS wave and her BMI in 2001 for the 2002 CDS wave. The definition for obesity among adults accepted by the CDC is a BMI above 30. In our sample, over 27% of less educated mothers are obese while almost 19% of more educated mothers are obese. The difference in father's BMI between the two groups is slightly less pronounced. We include a control for the number of hours worked by the father because father's time may affect child's weight and, given assortative mating and specialization in marriage, is likely related to mother's work hours (although the coefficient on father's hours is not significant in any specification). We include whether the mother receives food stamps as there is some evidence of a positive effect of food stamps on obesity (Gibson 2003) (although the coefficient on food stamp receipt is not significant in any specification).

2.1 Replication

Before describing the time diaries which allow us to investigate the mechanisms by which mother's employment can affect a child's BMI, we want to confirm that the empirical relationship between mother's employment and child's BMI exists in the PSID. Most of the previous American studies on this issue used the NLSY. We replicate the previous analysis using PSID data in Table 2. For comparison, we construct control variables similar to those used by Anderson et al. (2003). We find that, in the full sample, mother's work hours over the child's lifetime are positively correlated with the probability that the child is overweight. In addition, consistent with Anderson et al. (2003), Lamerz et al. (2005), and Ruhm 2008), the effect of maternal employment is greater for more advantaged children (those with a more educated mother). Thus, this relationship appears to exist across several data sources.

2.2 Time diaries

The time diaries are a unique feature of these data. Time diaries have been shown in various studies to provide valid information about one's activities.[2] In the CDS, the

[2] For a review, see Robinson and Bostrum (1994). More recent studies include Yaroch et al. (2006), and Chodick et al. (2008).

Table 2 Replication of result that mother's employment affects probability of being overweight

Dependent variable: overweight			
Sample	Full sample	Mother's Ed $\leq$ 12	Mother's Ed > 12
Log hours/week worked by mother over child's life	0.016*	0.006	0.021*
	(0.006)	(0.009)	(0.010)
Child's age	−0.019*	−0.017	−0.021+
	(0.009)	(0.013)	(0.012)
Child's age squared	0.001	0.000	0.000
	(0.000)	(0.001)	(0.001)
Black	0.068**	0.056+	0.086**
	(0.021)	(0.029)	(0.032)
Hispanic	0.145**	0.174**	0.152*
	(0.038)	(0.051)	(0.064)
Female	−0.050**	−0.040*	−0.052**
	(0.013)	(0.020)	(0.019)
First born child	0.014	0.009	0.018
	(0.015)	(0.022)	(0.023)
Birth weight (pounds)	0.016**	0.016*	0.019*
	(0.006)	(0.008)	(0.008)
Number of children in household	−0.011	−0.011	−0.004
	(0.008)	(0.010)	(0.012)
Age of mother at birth	0.002	0.001	0.002
	(0.001)	(0.002)	(0.002)
Education of mother in 1997 (years)	−0.005	−0.000	−0.021*
	(0.003)	(0.005)	(0.009)
Mother is obese (BMI>30)	0.149**	0.116**	0.184**
	(0.020)	(0.026)	(0.032)
Breastfed	−0.042*	−0.048*	−0.027
	(0.017)	(0.023)	(0.024)
Fraction of child's life parents married	−0.031	−0.001	−0.095*
	(0.025)	(0.034)	(0.040)
Log labor income/1000 over child's life	−0.008	−0.002	0.006
	(0.010)	(0.014)	(0.015)
Log hours/week worked by father over child's life	−0.008	−0.013	−0.007
	(0.010)	(0.015)	(0.017)
Northeast	−0.027	−0.021	−0.019
	(0.022)	(0.035)	(0.030)
North Central	−0.013	−0.030	0.000
	(0.019)	(0.027)	(0.029)
West	−0.033	−0.035	−0.033
	(0.021)	(0.031)	(0.031)
Urban	−0.021	−0.047*	0.006
	(0.016)	(0.023)	(0.022)

Table 2 continued

Dependent variable: overweight			
Sample	Full sample	Mother's Ed $\leq$ 12	Mother's Ed $>$ 12
2002 interview	0.057**	0.058**	0.064**
	(0.015)	(0.022)	(0.023)
Observations	4290	2188	1911

Robust standard errors in parentheses. Standard errors adjusted for intra−cluster correlations at the family level. + significant at 10%; * significant at 5%; ** significant at 1%

primary caregiver or the child was asked to write down what the child was doing at every point in time over 2 days—1 week day and 1 weekend day. We have taken this information and divided the child's time into 16 categories: sleeping, eating, attending school, being baby-sat, attending to the personal care of oneself or others, reading/talking/listening to music, watching TV, playing indoor games, socializing, shopping, traveling, playing on the computer or with video games, doing homework, playing sports, doing chores around the house or working for pay, and other miscellaneous passive activities, e.g. hobbies and watching others do activities. For a detailed list of the specific activities included in each category, see the Appendix.

Since a child can be engaged in multiple activities simultaneously, the time diary permits two activities to be assigned to any given time—a primary and a secondary activity. For example, a child could be watching television while being in daycare. Either one of these could be listed as the primary or secondary activities. We use all of the available information and, as a result the total number of hours accounted for over the 2 days is greater than 48 h.

Table 3 provides the number of hours that a child spends on these activities by the child's age and mother's education. These activities are sorted by time use in the first column. By far, sleeping takes the most amount of time. After sleeping, children spend most of their time reading/talking/listening to music, in school, and watching TV.

One potential problem for our analysis is the possibility that the data quality of the time diary entries may be worse for mothers who work. That is, mothers who work may know less about their child's activities and thus report those activities with more measurement error. It is true that children are more likely to fill out the diary themselves if their mother works more hours. However, on average, the children of mothers who work long hours are older and the age of the child is the strongest predictor of how involved the child was in filling out the diary. This measurement error argument assumes that the mother is a more accurate reporter of their children's activities than the children themselves. However, mothers are more likely to be influenced by social norms in their responses than children, so one could make the argument that measurement error is smaller when children report their own activities. In any case, we argue that any bias from this type of measurement error is negligible because when we control for whether the mother filled out the diary without the child's help, the results presented in this paper are unchanged.

Table 3 Average time use over 2 days by mother's education and child's age (in hours)

	Mother's Ed ≤ 12		Mother's Ed > 12	
	Child's age < 10	Child's age ≥ 10	Child's age < 10	Child's age ≥ 10
Sleeping	22.0	20.4	21.7	19.8
Reading/talking/listening music	6.6	7.8	6.9	7.9
Attending school	5.3	5.5	5.1	5.9
TV watching	5.3	5.8	4.5	5.3
Eating	3.1	2.9	3.1	2.9
Playing indoor games	2.9	0.8	3.1	0.8
Sports	2.7	2.1	2.5	2.0
Personal care of self/others	2.2	2.5	2.0	2.4
Socializing	1.6	1.8	1.7	2.1
Misc. passive activities	1.4	1.2	1.9	1.3
Traveling	1.3	1.5	1.4	1.7
Shopping	1.0	1.1	1.2	1.0
Chores/work	0.8	1.8	0.9	1.6
Computer/video games	0.8	1.7	0.9	1.8
In child care	0.8	0.1	0.9	0.1
Homework	0.5	0.9	0.5	1.4
Total[a]	58.4	57.7	58.5	57.9
Observations	825	908	788	752

Note: A description of each of the categories is provided in the appendix

[a] Total is greater than 48 h because at any given time, two activities can be reported

Finally, these data also provide a few diet-related aspects of the household. These are shown in Table 4. We know from the time diary whether meals take place in a restaurant or at home. However, we cannot distinguish whether the meal eaten at home is from a restaurant (like take-out or delivery pizza). On average, fewer than six meals were eaten over the 2 days, and less than one on average was eaten in a restaurant. We are also interested in breastfeeding and allowances which can be affected by maternal employment and may impact a child's nutritional intake. These variables are available

Table 4 Determinants of diet by mother's work hours

	Mother's Ed ≤ 12		Mother's Ed > 12	
	Child's age < 10	Child's age ≥ 10	Child's age < 10	Child's age ≥ 10
Total number of meals	5.8	4.8	6.4	5.1
Percent of meals in a restaurant	9.7%	11.9%	12.2%	14.6%
Child breastfed as infant	36.4%	34.7%	62.8%	57.3%
Percent with an allowance (age > 5)	61.4%	59.3%	57.6%	53.1%
Observations	825	908	788	752

from the CDS parent interview. Although we find a negligible difference in the probability of a child being breastfed among mothers by working hours (not shown), more educated mothers are almost twice as likely to have breastfed. Between 50 and 60% of children over the age of 5 receive an allowance.

3 The empirical strategy

The goal of this paper is to investigate the channels through which maternal employment affects children's BMI. We assume that maternal employment affects the number and composition of meals and the nature of her children's activities, which in turn influence calorie intake and expenditure, thereby affecting the child's BMI. Thus, our empirical strategy is to estimate the effect of maternal work hours on child's BMI controlling for a wide variety of potential channels.

More formally, we estimate several regression equations, one for each of the potential channels for which we have data. This estimation strategy has been used in other contexts by Hoxby (2000); Levine and Rothman (2006), and Baum and Ruhm (2007) and we follow their example. As a baseline, we first measure the effect of maternal employment, MWH, on a child's percentile BMI, *pBMI*, using OLS estimation. We use the log of mother's work hours to reduce the effect of a few mothers who work a large number of hours per week.[3] In this regression we do not include any possible channels, but only control variables for characteristics of the child and family, *X*. This regression equation is given by

$$pBMI_i = \alpha_0 + \alpha_1 \ln(MWH)_i + \alpha_2 X_i + \varepsilon_i. \quad (1)$$

Each additional equation also includes one potential channel. In Eq. 2, for example, time spent watching TV is added. Thus we estimate

$$pBMI_i = \beta_0 + \beta_1 \ln(MWH)_i + \beta_2 TV_i + \beta_3 X_i + \mu_{i,} \quad (2)$$

where ε_i and μ_i are idiosyncratic error terms with mean zero. Thus a reduction in the marginal effect of maternal employment on the child's percentile BMI in the presence of a potential channel, such as watching television, can be interpreted as the part of the effect of maternal employment operating via that channel. In addition, we test whether $\alpha_1 = \beta_1$, and report the difference $(\alpha_1 - \beta_1)$ and the corresponding robust standard errors. We adjust the standard errors in all regressions for intra-cluster correlations at the family level.

Thinking of each potential channel as an omitted variable is useful in interpreting the values of the coefficients we present. The omitted variable equation is given by:

$$\alpha_1 \approx \beta_1 + \beta_2 \rho, \quad (3)$$

where α_1, β_1, and β_2 are the coefficients from Eqs. 1 and 2, and ρ represents the correlation between mother's working hours and the potential channel, in this case, the amount of time a child spends watching TV. Thus, a positive coefficient on the difference $(\alpha_1 - \beta_1)$ indicates that $\beta_2 \rho > 0$, suggesting that the effect of the

[3] If MWH < 1, the value is bumped up to 1 so that ln MWH $= 0$. The results are qualitatively the same whether maternal work hours are logged or not.

potential channel on the child's percentile BMI (β_2) and the correlation between MWH and the potential channel (ρ) are the same sign. For example, if $\alpha_1 - \beta_1 > 0$ when watching TV is included in the specification, then this suggests that the effect of TV watching on child's BMI percentile is positive and TV watching is positively correlated with mother's work hours. Alternatively, both β_2 and ρ could be negative, meaning that an activity decreases a child's BMI and higher maternal employment decreases the amount of time a child spends on this activity. Given this, we could interpret this significant difference as suggesting that the direct effect of mother's working hours on the child's BMI is reduced when TV watching is included in the specification. On the other hand, a negative value indicates that β_2 and ρ have opposite signs. For example, if $\alpha_1 - \beta_1 < 0$ when "attending school" is included in the specification, then this suggests that, since we expect that mother's working hours and the time spent attending school are positively correlated, the effect of attending school on child's BMI is negative. Thus, if this coefficient was significant, it would suggest that mothers' working could reduce their child's BMI because the child spends more time attending school.

Besides using percentile BMI as a dependent variable, we also estimate two sets of Probit regressions with the dependent variables representing whether the child is overweight or at risk of overweight (BMI percentile above 85) or simply overweight (BMI percentile above 95). The goal for the Probit regressions is to evaluate the effects of potential channels at the right tail of the weight distribution. We report marginal effects in all tables.

In all of the regressions, we control for the variables listed in Table 1 plus child's age squared, whether the time diary was taken in the winter months, winter interacted with the North Central region, winter interacted with the Northeast region, whether the weekend day of the diary was a Saturday (vs. a Sunday), which wave of the CDS the observation comes from, and whether the mother answered the time diary without the assistance of the child. South is the omitted region category. We also include missing indicators for all of the control variables included.

4 The results

Table 5 presents the results of our analysis using the full sample. The first column uses percentile BMI and the second and third columns use the risk of overweight and overweight cutoff categories described above. The first row presents α_1 from Eq. 1, the effect of log mother's working hours on the dependent variable with only the family and child characteristics included in the specification. The rest of the table reports the difference between α_1 and β_1^j, where j indicates which one of the twenty potential channels is included in the specification. For example, including the number of meals reduces the coefficient on maternal employment on BMI percentile from 1.339 to 1.216 (1.339–0.123). The potential channels are listed to the left of the coefficient and the significance levels of the difference are indicated with asterisks after the coefficient.

We can see in Table 5 that maternal working hours are associated with a significant increase in all three measures of child's weight for the full sample of

Table 5 The change in the effect of mother's employment on child's weight for the full sample, by channel

Dependent variable	percentile BMI	>85th percentile	>95th percentile
Ln MWH	1.339**	0.021**	0.014*
	(0.489)	(0.008)	(0.007)
Number of meals	0.123*	0.0040*	0.0027
	(0.044)	(0.0017)	(0.0017)
% meals in restaurant	0.023	0.0010	0.0002
	(0.018)	(0.0008)	(0.0006)
Breastfed	0.021	−0.0001	−0.0005
	(0.026)	(0.0011)	(0.0014)
Receives allowance	−0.003	0.0002	0.0001
	(0.009)	(0.0004)	(0.0004)
Fraction of time spent			
Sleeping	0.004	0.0004	0.0005
	(0.009)	(0.0006)	(0.0007)
Reading/talking/listening music	0.049+	0.0013	0.0021
	(0.030)	(0.0010)	(0.0014)
Attending school	−0.010	−0.0006	−0.0002
	(0.019)	(0.0009)	(0.0010)
TV watching	0.042+	0.0022+	0.0015
	(0.026)	(0.0013)	(0.0012)
Eating	0.018	0.0007	0.0011
	(0.017)	(0.0008)	(0.0010)
Playing indoor games	0.005	0.0001	0.0005
	(0.012)	(0.0005)	(0.0007)
Sports	0.000	0.0002	0.0000
	(0.004)	(0.0007)	(0.0001)
Personal care of self/others	0.007	0.0000	−0.0006
	(0.010)	(0.0004)	(0.0006)
Socializing	0.011	0.0002	0.0002
	(0.016)	(0.0004)	(0.0005)
Misc. passive activities	−0.002	0.0002	0.0000
	(0.010)	(0.0004)	(0.0004)
Traveling	−0.009	−0.0007	−0.0005
	(0.012)	(0.0007)	(0.0006)
Shopping	0.003	0.0001	0.0000
	(0.007)	(0.0003)	(0.0005)
Chores/work	0.009	0.0003	0.0010
	(0.015)	(0.0007)	(0.0009)
Computer/video games	0.000	0.0000	0.0000
	(0.006)	(0.0002)	(0.0003)

Table 5 continued

Dependent variable	percentile BMI	>85th percentile	>95th percentile
In child care	−0.040	0.0002	−0.0012
	(0.038)	(0.0015)	(0.0017)
Homework	0.017	0.0004	0.0001
	(0.018)	(0.0005)	(0.0003)
Observations	3424	3424	3424

The first row presents the effect of ln MWH on the dependent variable. All of the following rows present the difference between the coefficient in the first row and the coefficient on ln MWH if the variable listed to the left is included in the specification. Each coefficient is from a separate regression. OLS estimation is used in the first column and probit in the second and third columns. Marginal effects are reported in all columns. Robust standard errors are in parentheses. Standard errors are adjusted for intra-cluster correlations at the family level. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%

mothers. The only three channels whose inclusion results in a significant difference are the number of meals, the time spent reading/talking/listening to music, and the time spent watching TV. The decline associated with including the number of meals explains about 9% (0.123/1.339 = 0.09) of the effect of maternal working hours on child's percentile BMI, 19% (0.004/0.021 = 0.19) of the effect on the probability of being at risk of overweight with no significant effect for probability of overweight. The decline associated with including reading/talking/listening to music explains about 4% of the effect on BMI percentiles. Similarly, the decline associated with including watching TV explains about 3% of the effect on BMI percentiles, and 10% on probability of being at risk of overweight. The TV watching result has been found in other research (Proctor et al. 2003; Hancox et al. 2004). We find evidence in these data that TV watching and reading/talking/listening to music are substitutes. In particular, holding all else constant, children who watch TV more spend significantly less time reading/talking/listening to music. While reading/talking/listening to music is a passive set of activities like TV watching, they may be healthier activities in that they are less complementary to eating junk food than is TV watching. Thus, these results parallel each other; consistent with this, their magnitudes are similar. The result that requires further discussion is the effect of the number of meals.

Research has found an inverse relationship between frequency of eating and BMI (Ma et al. 2003) and the importance of breakfast (Stauton and Keast 1989; Morgan et al. 1986), both of which are consistent with this finding. In some additional analysis that we conducted (not shown), we found that the inclusion of the number of breakfasts (defined as a meal that occurs between 5 AM and 11 AM), whose value can be 0, 1, or 2, renders the coefficient on the number of meals insignificant. The coefficient on the number of breakfasts is significant so we interpret this pattern as suggesting that the effect of the number of meals on child's percentile BMI through mother's work hours is explained by skipping breakfasts. The probability of having 2 breakfasts over the 2 diary days is 67% for mothers who work <10 h/week but only 46% for mothers who work fulltime or more (34+ hours/week). Other variables which are also related to the number of meals were inspected but none of them had significant coefficients or altered the coefficient on the number of meals.

In particular, we examined the effect of the number of breakfasts, where breakfast was defined as a meal within 2 h of waking up after a sleep of 5 h or more; the effect of whether the primary caregiver says that the child regularly has breakfast; and the effect of whether the child participated in a federal breakfast/lunch program. Thus, we argue that the evidence points toward skipping breakfast as an important mechanism. Our evidence is consistent with findings in a large body of literature that finds a pronounced correlation between skipping breakfast and overweight and obesity (Gibson and O'Sullivan 1995; Pastore et al. 1996; Ortega et al. 1998; Summerbell et al. 1996; Wolfe et al. 1994).

However, it may be that children who never miss breakfast also eat more nutritiously in general and since neither of our measures of the number of meals nor the number of breakfasts captures the calorie content or size of the meals, we cannot rule out other explanations. In particular, there is evidence that working married mothers spend a smaller share of their food budgets on vegetables, fruits, milk, and meat and beans than non-working married mothers (Ziol-Guest et al. 2006), suggesting that the content of the meals may be the important factor.

In any case, it is surprising that the effect of number of meals is stronger than the effect of TV watching or reading/talking/listening to music. Even more surprising is the small number of significant effects observed overall. In particular, we expected that time in the care of others and playing sports would have an effect; however, the zero effect of sports is consistent with Cawley et al. (2007), who find that an increase in *mandated* time for physical activity in school does not have a significant impact on children's BMI.

To determine if the effect varies by mother's education, we repeat this strategy on two subsets of the sample divided by mother's education. These results are presented in Table 6. For mothers with a high school education or less, the effects of mother's working hours on percentile BMI and the probability of being (at risk of) overweight are not significant in the baseline specifications. For more educated mothers, the total effect of the mother's working hours is large and highly significant. This effect is roughly 50% larger than in the full sample and many times larger than in the sample of mothers with less education. This difference between education groups that we find is consistent with Anderson et al. (2003).

We observe that the number of meals significantly changes the coefficient on MWH for more educated mothers only. The fact that we find a stronger effect for more educated mothers may imply that missing meals is more important for these children because the mothers know more about nutritious meals and transfer the knowledge of healthy eating to their children. However, the difference between the education groups in the difference in the effects is not significant (not shown on the table). One interesting difference by education does appear however. For less educated mothers, the effect of mother's work hours is reduced when we control for the time spent in school. In contrast, for more educated mothers, the effect of mother's work hours is reduced when we control for the time spent in child care. These differences across education groups are both significant.

The interpretation of this finding may be causal, a correlation or due to reverse causality. In additional analysis (not shown), we find that the effect of school for less educated mothers is only significant when school-age children (age 5–16) who

Table 6 The change in the effect of mother's employment on child's weight, by mother's education and channel

Sample	Mother's Ed ≤ 12			Mother's Ed > 12		
Dependent variable	percentile BMI	>85th percentile	>95th percentile	percentile BMI	>85th percentile	>95th percentile
Ln MWH	0.356	0.009	0.004	2.013**	0.025*	0.017+
	(0.645)	(0.011)	(0.009)	(0.758)	(0.012)	(0.010)
Number of meals	0.052	0.0020	0.0009	0.1503*	0.0044	0.0024
	(0.041)	(0.0018)	(0.0017)	(0.075)	(0.0030)	(0.0033)
% meals in restaurant	0.006	0.0004	0.0000	0.047	0.0017	0.0000
	(0.013)	(0.0009)	(0.0003)	(0.039)	(0.0018)	(0.0017)
Breastfed	0.010	−0.0023	−0.0028	0.002	0.0002	0.0010
	(0.046)	(0.0017)	(0.0018)	(0.019)	(0.0013)	(0.0019)
Receives allowance	−0.005	0.0003	0.0010	−0.002	0.0000	0.0002
	(0.022)	(0.0011)	(0.0014)	(0.008)	(0.0004)	(0.0008)
Fraction of time spent						
Sleeping	−0.004	0.0005	0.0001	0.008	0.0005	0.0011
	(0.025)	(0.0011)	(0.0012)	(0.022)	(0.0014)	(0.0023)
Reading/talking/ listening music	0.058	0.0007	0.0015	0.022	0.0019	0.0027
	(0.046)	(0.0012)	(0.0020)	(0.038)	(0.0019)	(0.0026)
Attending school	−0.103+	−0.0041+	−0.0009	0.020	0.0007	0.0001
	(0.054)	(0.0023)	(0.0019)	(0.027)	(0.0011)	(0.0009)
TV watching	0.007	0.0004	0.0000	0.036	0.0044	0.0046
	(0.024)	(0.0012)	(0.0009)	(0.060)	(0.0030)	(0.0035)
Eating	−0.010	0.0000	0.0008	−0.004	0.0000	−0.0001
	(0.032)	(0.0016)	(0.0019)	(0.044)	(0.0014)	(0.0017)
Playing indoor games	0.004	0.0003	0.0003	0.012	−0.0003	0.0019
	(0.011)	(0.0006)	(0.0008)	(0.032)	(0.0015)	(0.0020)
Sports	−0.004	−0.0003	−0.0001	−0.005	0.0001	0.0000
	(0.023)	(0.0017)	(0.0006)	(0.027)	(0.0003)	(0.0001)
Personal care of self/others	−0.013	−0.0008	−0.0019	−0.034	−0.0006	−0.0003
	(0.029)	(0.0013)	(0.0016)	(0.040)	(0.0010)	(0.0011)
Socializing	0.005	0.0000	0.0001	0.007	0.0003	0.0004
	(0.023)	(0.0002)	(0.0004)	(0.020)	(0.0008)	(0.0011)
Misc. passive activities	−0.013	−0.0001	0.0004	0.001	0.0000	−0.0001
	(0.019)	(0.0006)	(0.0009)	(0.006)	(0.0002)	(0.0011)
Traveling	−0.025	−0.0013	−0.0004	−0.002	−0.0003	−0.0007
	(0.029)	(0.0015)	(0.0008)	(0.012)	(0.0009)	(0.0012)
Shopping	0.002	0.0001	0.0000	0.000	0.0001	−0.0001
	(0.011)	(0.0009)	(0.0011)	(0.001)	(0.0006)	(0.0005)
Chores/work	0.026	0.0009	0.0011	−0.003	−0.0002	0.0003
	(0.026)	(0.0011)	(0.0012)	(0.013)	(0.0007)	(0.0012)

Table 6 continued

Sample	Mother's Ed ≤ 12			Mother's Ed > 12		
Dependent variable	percentile BMI	>85th percentile	>95th percentile	percentile BMI	>85th percentile	>95th percentile
Computer/video games	−0.004	0.0001	−0.0002	0.009	0.0003	−0.0001
	(0.019)	(0.0008)	(0.0006)	(0.022)	(0.0010)	(0.0005)
In child care	0.045	0.0009	0.0010	−0.153+	0.0003	−0.0053+
	(0.039)	(0.0017)	(0.0023)	(0.081)	(0.0032)	(0.0031)
Homework	−0.001	0.0000	0.0001	0.049	0.0014	0.0004
	(0.016)	(0.0008)	(0.0011)	(0.043)	(0.0016)	(0.0011)
Observations	1,733	1,733	1,733	1,537	1,537	1,537

The first row presents the effect of ln MWH on the dependent variable. All of the following rows present the difference between the coefficient in the first row and the coefficient on ln MWH if the variable listed to the left is included in the specification. Each coefficient is from a separate regression. OLS estimation is used in the first column and probit in the second and third columns. Marginal effects are reported in all columns. Robust standard errors are in parentheses. Standard errors are adjusted for intra-cluster correlations at the family level. + significant at 10%; * significant at 5%; ** significant at 1%.

did not attend school either of the time diary days are included. This suggests that school absences, rather than attending before or after school programs, for example, are driving this result. In addition, we find that the child care result is driven by children in fair or poor health. If we restrict the sample to only those children whose primary caregiver rates their health as excellent, very good or good (97% of the sample), the child care result disappears.[4] Thus, mothers who work more hours may ensure that their children do not miss school or child care, consistent with Nomaguchi (2006), and this reduces their BMI. However, it may be that parents who ensure that their children do not miss school or child care are also less likely to have overweight children. Or, alternatively, it may be that overweight children are more likely to miss school or child care for health reasons and this affects their mother's ability to work more hours consistently. The latter two interpretations would imply that a change in mothers' hours would not change their children's weight status. We are not able to determine which of the interpretations are accurate without additional analysis beyond the scope of this study.

There is some concern that our main measure of maternal work hours, which captures only the current pattern of employment, may limit the effect of maternal work since weight status is the cumulative result of many years of behaviors. That is, past maternal work may have an effect on current weight which we are not capturing. To address this concern, we use mother's work hours since birth, not just the last 2 years. These results are presented in Table 7 and suggest that long run and short run maternal employment affects child weight similarly. Specifically, for the full sample, only the inclusion of the number of meals and TV watching lead to significant changes in the effect of mother's work. Reading/talking/listening to music is positive and similar to TV watching in magnitude as in Table 5, but the

[4] The attending school result is robust to this sample restriction.

Table 7 The change in the effect of mother's employment over child's life on child's weight, by channel

Sample	Full sample		Mother's Ed ≤ 12		Mother's Ed > 12	
Dependent variable	percentile BMI	>85th percentile	percentile BMI	>85th percentile	percentile BMI	>85th percentile
Ln MWH	1.323*	0.020*	0.435	0.010	1.961*	0.023+
	(0.560)	(0.009)	(0.772)	(0.012)	(0.857)	(0.014)
Number of meals	0.1316**	0.0042*	0.0593	0.0023	0.1448*	0.0043
	(0.0464)	(0.0019)	(0.0476)	(0.0021)	(0.0699)	(0.0029)
% meals in restaurant	0.0255	0.0012	0.0096	0.0008	0.0452	0.0016
	(0.0197)	(0.0010)	(0.0177)	(0.0011)	(0.0400)	(0.0018)
Breastfed	0.0364	0.0009	0.0742	0.0000	−0.0066	0.0006
	(0.0332)	(0.0014)	(0.0607)	(0.0022)	(0.0265)	(0.0016)
Receives allowance	−0.0051	0.0003	−0.0077	0.0005	−0.0061	0.0002
	(0.0135)	(0.0007)	(0.0309)	(0.0015)	(0.0195)	(0.0008)
Fraction of time spent						
Sleeping	0.0078	0.0008	−0.0063	0.0007	0.0275	0.0016
	(0.0159)	(0.0008)	(0.0378)	(0.0015)	(0.0326)	(0.0018)
Reading/talking/ listening music	0.0461	0.0014	0.0637	0.0009	0.0207	0.0018
	(0.0294)	(0.0011)	(0.0505)	(0.0014)	(0.0337)	(0.0019)
Attending school	−0.0067	−0.0004	−0.1239*	−0.0049*	−0.0042	0.0001
	(0.0143)	(0.0007)	(0.0595)	(0.0025)	(0.0268)	(0.0008)
TV watching	0.0530+	0.0028+	0.0091	0.0003	0.0454	0.0060
	(0.0319)	(0.0015)	(0.0255)	(0.0013)	(0.0789)	(0.0039)
Eating	0.0144	0.0005	−0.0093	0.0000	−0.0187	−0.0003
	(0.0147)	(0.0006)	(0.0297)	(0.0014)	(0.0477)	(0.0015)
Playing indoor games	0.0061	0.0002	0.0133	0.0009	0.0107	−0.0002
	(0.0151)	(0.0007)	(0.0272)	(0.0013)	(0.0248)	(0.0014)
Sports	0.0002	0.0007	0.0132	0.0008	−0.0151	0.0001
	(0.0106)	(0.0009)	(0.0279)	(0.0019)	(0.0297)	(0.0006)
Personal care of self/others	−0.0002	0.0000	−0.0079	−0.0005	−0.0732	−0.0013
	(0.0073)	(0.0001)	(0.0196)	(0.0009)	(0.0510)	(0.0016)
Socializing	0.0019	0.0000	−0.0210	−0.0002	0.0081	0.0004
	(0.0133)	(0.0003)	(0.0280)	(0.0010)	(0.0222)	(0.0010)
Misc. passive activities	−0.0048	0.0003	−0.0256	−0.0002	0.0024	0.0001
	(0.0166)	(0.0007)	(0.0328)	(0.0013)	(0.0112)	(0.0006)
Traveling	−0.0177	−0.0015	−0.0509	−0.0030	−0.0036	−0.0005
	(0.0210)	(0.0011)	(0.0457)	(0.0021)	(0.0213)	(0.0013)
Shopping	0.0044	0.0001	−0.0018	−0.0001	0.0004	−0.0001
	(0.0081)	(0.0003)	(0.0128)	(0.0010)	(0.0087)	(0.0007)
Chores/work	0.0116	0.0003	0.0330	0.0011	−0.0041	−0.0001
	(0.0183)	(0.0008)	(0.0302)	(0.0013)	(0.0177)	(0.0006)
Computer/video games	−0.0002	0.0000	−0.0061	0.0000	0.0058	0.0002
	(0.0054)	(0.0002)	(0.0200)	(0.0008)	(0.0144)	(0.0005)

Table 7 continued

Sample	Full sample		Mother's Ed ≤ 12		Mother's Ed > 12	
Dependent variable	percentile BMI	>85th percentile	percentile BMI	>85th percentile	percentile BMI	>85th percentile
In child care	−0.0414	0.0003	0.0552	0.0011	−0.1400+	0.0005
	(0.0403)	(0.0016)	(0.0437)	(0.0019)	(0.0777)	(0.0030)
Homework	0.0125	0.0002	−0.0007	0.0000	0.0346	0.0009
	(0.0164)	(0.0004)	(0.0149)	(0.0006)	(0.0384)	(0.0012)
Observations	3,424	3,424	1,733	1,733	1,537	1,537

The first row presents the effect of ln MWH over the child's life on the dependent variable. All of the following rows present the difference between the coefficient in the first row and the coefficient on ln MWH if the variable listed to the left is included in the specification. Each coefficient is from a separate regression. OLS estimation is used when the dependent variable is BMI percentile and probit is used when the dependent variable is risk of overweight. Marginal effects are reported. Robust standard errors are in parentheses. Standard errors are adjusted for intra-cluster correlations at the family level. $^{+}$ significant at 10%; * significant at 5%; ** significant at 1%

difference is not significant in this case. As in Table 6, when the sample is divided by education, three potential channels have a significant effect on child weight.

As a final consideration, we address the possibility that our findings are dependent on the particular estimation strategy used here. As one check, we decompose the effects by each potential channel and find similar results. In particular, we estimate the effect of children's activities and meal routines on BMI, and separately estimate the effect of maternal employment on these activities and routines. These results are shown in Appendix Table 9.

Combining these two decomposed effects supports our interpretations of the findings discussed above. First, we find that the number of meals is significantly and negatively associated with percentile BMI, and mother's work hours are significantly and negatively associated with the number of meals. The combined effect is consistent with the positive value found on Tables 5 and 6 related to the number of meals, suggesting that more hours working increases children's BMI through the mechanism of fewer meals. Second, reading/talking/listening to music is significantly and negatively associated with percentile BMI, and mother's work hours are significantly and negatively associated with the time spent reading/talking/listening to music. The combined effect is consistent with the positive value found on Table 5, suggesting that more hours working increases children's BMI through the mechanism of reading/talking/listening to music. Third, we find that for less educated mothers, the time in school is significantly and negatively associated with percentile BMI, and mother's work hours are significantly and positively associated with time spent in school. The combined effect suggests that among these mothers, more hours working is associated with their children having a lower BMI through the mechanism of school attendance. Fourth, for the full sample, we find that TV watching is significantly and positively associated with high percentile BMI, and that mother's work hours are significantly and positively associated with more time spent watching TV. The combined effect suggests that more work hours is

associated with a higher child's BMI through the mechanism of TV watching. Finally, we find that for all mothers, more work hours are significantly associated with more time spent in child care, but for the more educated mothers, more time spent in child care is associated with lower child BMI (although not significantly). This combines to produce the effect that more work hours is associated with lower child BMI through the mechanism of child care.

5 Conclusions

In this paper, we have replicated the empirical connection found in the NLSY between mother's employment and childhood BMI percentile/obesity for the PSID. We then inspect the mechanisms which connect hours worked by the mother to BMI percentile/obesity of the child. We find that maternal employment is related to children's BMI through the average number of meals consumed in a day, through reading/talking/listening to music, and through TV watching, although the magnitudes are small. In addition, while the direct effect of the first two activities on children's BMI is negative, TV watching is associated with higher BMI. Some of these results complement the findings from Cawley and Liu (2007) who examine the time use of *mothers* using the American Time Use Survey and find that employed women spend less time cooking and eating with their children. We also find some evidence that mother's work hours are associated with their children having a lower BMI through an increased amount of time spent in school (in the case of less educated mothers) or child care (in the case of more educated mothers). Overall, we examine a large number of potential channels which theory and intuition would predict to be important and are able to explain a relatively small percentage of the total relationship.

Two important limitations of this study are the small sample size and the lack of detail available about meals. A larger sample would allow us to employ empirical techniques which address the endogeneity issues, such as fixed effects and instrumental variables estimation. A larger sample would also allow us to disaggregate by child's age which would sharpen the analysis since the activities of 3 year-olds are quite different from the activities of teenagers and the effects of maternal employment on childhood obesity are likely age specific. Despite the small sample sizes, we did find some evidence (not shown) that maternal work hours only affect TV watching for children over age 9.

We believe that a possible reason that we do not get stronger results on restaurant meals, as opposed to meals at home, for example, is that we do not have information on take-out meals. The pizza delivered from the hut to the home and eaten at home is as fattening as the pizza eaten in the hut. In our data set we can also not distinguish between a meal at a fast food restaurant and a salad in a conventional restaurant. We suspect that families who frequently eat greasy pizzas and fatty burgers in restaurants also use more fatty and calorie rich foods in meals that are cooked at home. Answering the question of how mother's employment affects childhood obesity via the channel of the number and variety of meals cooked requires a much more detailed data set.

Because of these limitations, we believe it would be premature to conclude that the majority of the mechanisms evaluated in this analysis are not relevant based on the results of this single study. Prior to making this conclusion, it is necessary to replicate these findings with other data and research strategies.

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Appendix: detailed activities in each time use category

Sleep: Includes night sleep, "in bed" but not asleep, naps and resting.

Miscellaneous passive activities: Includes household paperwork (paying bills, balancing checkbook, getting mail), watching another person do typically female household tasks, watching another person do typically male household tasks, watching another person do household tasks, baby care, giving child care, play with household children, helping children learn, coaching/leading outdoors/non-organization activities, help with homework, giving children instructions, disciplining children, conversations within household, reading to a child, personal/private activities, babysitting, coordinating or facilitating child's social or instructional activities, other child care and travel related to child care, affection activities between household members, positive emotional affect (smiling, laughing), negative emotional affect (crying, moaning), lessons in music, singing, instruments, other lessons, hobbies (photography, working on/repairing things, collections, carpentry/woodworking), domestic crafts (preserving food, needlework, sewing, care of animals, arts and crafts), pottery, painting, drawing and sculpture, writing poetry and writing in a diary, playing an instrument, whistling, singing for fun, karaoke, acting/rehearsing for a play, and travel related to passive leisure, travel of child with adult, and waiting in car for adult.

TV watching: Includes TV watching

Attending school: Includes regular full time classes, school field trips (that are part of or not a part of regular school hours), other classes and courses of academic or nonacademic nature, being tutored, other professional classes, military training, ROTC.

Eating: Includes meals at home, including coffee, drinking, food from a restaurant eaten at home, meals away from home, meals eaten at work, eating at restaurants, meals eaten at friends/relatives, snacks at home or away from home (new code for 2002).

Playing indoor games: Includes playing dress up, playing house, playing fireman, playing pretend, getting/giving makeovers, playing card games, playing board games, playing social games, doing puzzles or word/educational games, playing trivia games, playing with toys, unspecified play indoors (getting into stuff, making a mess, play wrestling), unspecified play games.

Sports: Includes lessons in dance, sports, gymnastics, yoga, judo, body movement, practices, organized meets and games for team and non-team sports (swimming, golf, tennis, skating, football, baseball/softball, basketball, volleyball, soccer, hockey, track and running, gymnastics or dance, squash and racquetball, ice skating, bowling, wrestling, martial arts, paddleball, water sports, other seasonal sports, skiing, sledding, snow boarding, skateboarding, pool, Frisbee, weight lifting, kickball, street hockey, rock climbing, trampoline, yoga), other out of doors sport activities (hunting, shooting, fishing, boating, sailing, camping, snowmobiling, extreme sports, bicycling, horseback riding, motorcycling, "off-roading," big wheels, tricycling), non social dancing (ballet, modern dance), playing social games, unspecified play outdoors.

Socializing: Includes volunteering and organization helping activities (attending meetings for hospital volunteer groups, community groups, after-school club groups; working as administrator or representative for hospital volunteer groups, community groups, after-school club groups; fundraising for hospital volunteer groups, community groups, after-school groups; direct help to individuals or groups as a member of a volunteer organization; and other activities related to a volunteering with an organization), attending religious services or individual or small group religious practices, meetings for church groups and other religious helping groups, activities related to attending professional and union organizations, activities related to child, youth, family organizations, activities related to fraternal organizations, activities related to political party and civic participation, activities related to special interest/identity organizations, activities related to before/after school clubs (math/science club, band/choir/orchestra, drama/art club, student council/yearbook/newspaper club, debate club, honors society, foreign language club, history/social science club), other miscellaneous organization activity and travel related to these activities, attending sports events (football games, baseball games, basketball games, volleyball games, soccer games, hockey games, swimming meets, track meets, gymnastics meet), seeing a movie, attending a theater, opera, or ballet, go to a museum or art gallery, going to the zoo, miscellaneous social and entertaining activities, visiting with others, socializing with other people outside of the household, talking/chatting, paying a visit, parties, wedding receptions, at a bar, at a nightclub, at a coffee shop, dancing, attending a dance, recreational alcohol use (new code for 2002), recreational drug use (new code for 2002), other events such as holiday events and decorating for a party.

Traveling: Includes travel to and from school (including waiting for parent/bus), other school related travel, travel to and from organizational events and meetings (as a helper and including waiting time for travel), travel to sport/leisure activities (including waiting for travel) vacation travel, travel to and from social/entertainment activities, household related travel (new code for 2002), passive leisure related travel (including waiting for related travel.

Shopping: Includes obtaining goods (groceries, household goods, cars, furniture, clothing), going to hardware stores, drug stores, department stores, shopping, going to the mall, window shopping, buying gas, personal care services (beauty, barber shop, hairdresser, tanning), medical care (doctors visits, dentist, making appointments),

financial services (going to the bank, paying bills, going to accountant, loan agencies, insurance offices), other government services (post office, passport, sporting licenses, marriage licenses, police station), auto services and repair, clothes repair and dry cleaning, appliance repair, household repair services, "running errands," other professional services non-specific, professional services from a lawyer, individual and group counseling or mental health services, picking up food at takeout place, other obtaining services, getting money/gift from adults (allowance, lunch money), related travel to obtaining goods and services.

Chores and work: Includes income producing activities, regular full-time paid work, work at home (activities done for pay at home), part time jobs (paper routes, babysitting), job searching (visiting work agencies, interviews, phone calls, answering want ads), other work-related activities, travel related to job search, travel to and from workplace (waiting for related travel), coffee breaks, before and after work activities, meal preparation, cooking, fixing lunches, serving food, setting table, putting groceries away, doing dishes, loading and unloading dishwasher, meal cleanup, clearing table, routine indoor cleaning and chores (dusting, making beds, washing windows, vacuuming, "housework"), laundry and clothes care, ironing, mending clothes, putting clothes away, maintenance and indoor repairs on the house (plumbing, painting, fixing), care of houseplants, repairing appliances and furniture, gardening, weeding, composting, picking, outdoor cleaning, yard work, raking leaves, mowing grass, garbage removal, cutting wood, cleaning garage, snow shoveling, outdoor repairs (fixing the roof, painting the house), home improvements (remodeling of house), improvements to grounds around the house, other outdoor and indoor household activities, pet care (including playing with pets, walking the dog), car care and necessary repairs, car maintenance (oil change, car wash, changed tires), and other household chores.

Computer/video games: Includes electronic video games, educational computer lessons, playing computer games, "surfing the net," downloading pictures and music, burning CD's, programming, computer communication, e-mail, instant messaging, chat rooms, financial computer services, online media, shopping on the computer, media activities on the computer, computer work, reading online newspapers, stock quotes, weather reports, installing hardware and software, computer library functions, non-specific computer work, computer repair/setup, computer photo processing, other PDA, "palm pilot" work, computer related travel, lessons in computers.

In child care: Includes at babysitters before or after school, child receives care if not in school, receiving child care, child is passive recipient of personal care, child being comforted by parent, daycare/nursery school for children not in school, daycare/nursery school before or after school.

Homework: Includes studying, research, reading, "went to library," reviewing homework with parent/caregiver, using the computer for homework and studying, and non-computer related homework.

Personal care of self or others: Includes waking up, going to bed, bathing, dressing, personal hygiene, going to the bathroom, medical care at home or outside home for self or others, going to the doctor, taking child to doctor, giving child medicine, non-medical care for adults in household, help and care to relatives not

Table 8 Descriptive statistics by mother's education without sample restrictions

	Mother's Ed ≤ 12 years		Mother's Ed > 12 years	
	Mean	*N*	Mean	*N*
Overweight (BMI > 95th percentile for age and sex)	21.7%	2,941	19.2%	2,399
Risk of overweight (85th percentile–95th percentile)	15.2%	2,720	14.8%	2,234
BMI of children	20.03	2,941	19.37	2,399
BMI percentile of children[a]	65.0	2,720	63.0	2,234
Hours per week worked by mother in last 2 years	19.32	3,871	24.00	2,817
Hours per week worked by mother over child's life	14.64	3,389	19.37	2,473
Mother didn't work in last 2 years	22.0%	3,389	12.3%	2,473
Mother never worked during child's life	14.4%	3,389	6.3%	2,473
Age of child	8.66	3,912	8.46	2,850
Black	45.9%	3,908	32.8%	2,840
Hispanic	11.1%	3,908	3.0%	2,840
Female	50.2%	3,912	48.1%	2,850
First born child	43.1%	3,898	59.2%	2,846
Birth weight (pounds)	7.15	3,828	7.41	2,810
Number of children in household	2.46	3,912	2.23	2,850
Age of mother at child's birth	26.37	3,606	28.73	2,818
Education of mother in 1997 (years)	10.23	3,912	14.81	2,850
Mother is obese (BMI > 30)	27.4%	3,767	19.1%	2,779
Father is obese (BMI > 30)	22.8%	2,971	18.6%	2,516
Parents always married over child's life	41.5%	3,389	67.1%	2,473
Annual labor income over child's life ('000)	$24.41	2,696	$50.72	2,158
Hours per week worked by father over child's life	33.30	2,533	38.91	2,087
Mother received foodstamps in last year	26.5%	3,424	6.3%	2,634
Northeast	10.0%	3,772	18.2%	2,785
North Central	24.0%	3,772	25.7%	2,785
South	47.5%	3,772	40.4%	2,785
West	18.4%	3,772	15.8%	2,785
Urban	54.2%	3,304	59.1%	2,579

[a] Percentiles based on 2000 CDC Growth Charts by gender and child's age in months

living in household, help and care to neighbors or friends, watching personal care activities, travel related to personal care or helping others with personal care, personal travel.

Reading/talking/listening to music: Includes listening to radio/music, reading (or looking at books, magazines, newspapers), being read to, conversations and talking on the phone or in person, arguing and fighting, relaxing (taking a break), reading or writing letters, reading mail, thinking, "doing nothing," smoking, joking, or laughing.

Table 9 The disaggregated effect of mother's employment on BMI, by channel

Sample	Full sample		Mother's Ed ≤ 12		Mother's Ed > 12	
Variable (V)	∂pBMI/∂V	∂V/∂lnMWH	∂pBMI/∂V	∂V/∂lnMWH	∂pBMI/∂V	∂V/∂lnMWH
Number of meals	−0.918**	−0.026**	−0.502	−0.020**	−1.011*	−0.028**
	(0.261)	(0.005)	(0.363)	(0.008)	(0.402)	(0.007)
% meals in restaurant	5.089+	0.005+	2.798	0.002	7.299+	0.007+
	(2.894)	(0.003)	(4.233)	(0.004)	(4.182)	(0.004)
Breastfed	−2.458+	−0.009	−3.858+	0.001	−0.168	−0.011
	(1.403)	(0.011)	(2.047)	(0.013)	(2.094)	(0.017)
Receives allowance	−0.345	0.010	−0.369	0.019	−0.429	0.005
	(1.171)	(0.009)	(1.704)	(0.014)	(1.752)	(0.014)
Fraction of time spent						
Sleeping	−5.911	−0.001	1.627	−0.002	−19.667	−0.000
	(9.654)	(0.001)	(13.158)	(0.001)	(15.142)	(0.001)
Reading/talking/listening Mmusic	−12.896*	−0.004**	−14.975*	−0.004+	−6.478	−0.005*
	(5.462)	(0.002)	(7.583)	(0.002)	(8.265)	(0.002)
Attending school	−3.433	0.002*	−30.699*	0.003**	19.549	0.001
	(9.133)	(0.001)	(12.495)	(0.001)	(13.916)	(0.001)
TV watching	17.595*	0.003*	15.528	0.000	11.095	0.005**
	(8.152)	(0.001)	(11.369)	(0.002)	(12.523)	(0.002)
Eating	−18.888	−0.001*	5.384	−0.002*	−58.272*	0.000
	(14.054)	(0.001)	(18.996)	(0.001)	(23.780)	(0.001)
Playing indoor games	−5.795	−0.001	−7.647	−0.001	−10.039	−0.002+
	(11.226)	(0.001)	(14.198)	(0.001)	(18.469)	(0.001)
Sports	−0.905	−0.000	−21.357	0.000	23.303	−0.000
	(11.382)	(0.001)	(15.395)	(0.001)	(16.781)	(0.001)
Personal care of self/others	15.061	0.000	−9.808	0.001+	63.197*	−0.001
	(18.010)	(0.000)	(21.440)	(0.001)	(27.428)	(0.001)
Socializing	−14.522	−0.001	−17.515	−0.000	−7.412	−0.001
	(12.115)	(0.001)	(18.011)	(0.001)	(15.246)	(0.001)
Misc. passive activities	2.361	−0.001	16.426	−0.001	−4.961	−0.000
	(13.155)	(0.001)	(20.396)	(0.001)	(18.727)	(0.001)
Traveling	−19.146	0.000	−51.059	0.000	−2.419	0.000
	(23.576)	(0.000)	(36.205)	(0.000)	(31.710)	(0.001)
Shopping	11.810	0.000	15.463	0.000	1.984	0.000
	(15.910)	(0.000)	(22.129)	(0.001)	(21.826)	(0.001)
Chores/work	9.313	0.001*	23.309	0.001	−2.700	0.001
	(12.097)	(0.001)	(15.952)	(0.001)	(18.567)	(0.001)
Computer/video games	−0.146	−0.001	20.932	−0.000	−10.295	−0.001
	(10.664)	(0.001)	(13.428)	(0.001)	(18.273)	(0.001)
In child care	−19.124	0.002**	41.884	0.001*	−52.629	0.002**
	(23.438)	(0.000)	(29.706)	(0.000)	(32.433)	(0.000)

Table 9 continued

Sample	Full sample		Mother's Ed ≤ 12		Mother's Ed > 12	
Variable (V)	∂pBMI/∂V	∂V/∂lnMWH	∂pBMI/∂V	∂V/∂lnMWH	∂pBMI/∂V	∂V/∂lnMWH
Homework	−35.035+	−0.001	−0.921	0.000	−47.384+	−0.001
	(20.016)	(0.000)	(33.672)	(0.000)	(25.936)	(0.001)

The coefficients in columns 1, 3, and 5 present the estimated effect of the variable listed to the left on percentile BMI. The coefficients in columns 2, 4, and 6 present the estimated effect of ln MWH on the the variable listed to the left. Each coefficient comes from a separate regression. OLS estimation is used in all regressions except when the dependent variable is the number of meals (poisson estimation is used in this case) or breastfed or received allowance (probit is used in these cases). Marginal effects are reported in all columns. Robust standard errors are in parentheses. + significant at 10%; * significant at 5%; ** significant at 1%

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