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The Impact of Maternal Occupation and Pre-Pregnancy Weight Status on Childhood Obesity

Jessica Schuring
Central College

Matched mother/child data from the 2008 National Longitudinal Survey of Youth are used to estimate how child, maternal, and household characteristics—including the mother's occupation and pre-pregnancy weight status—affect the probability of childhood obesity. The results suggest that a mother being overweight or obese before pregnancy increases her child's risk of obesity later in childhood. The probability of childhood obesity is also impacted by maternal occupation.

***Key words*:** childhood obesity, maternal employment, maternal pre-pregnancy weight status.

Introduction

Childhood obesity[1] is rapidly becoming one of the largest health concerns in the United States. During the 1963-1970 period, only 4.2% of children ages 6 to 11 years were considered obese, while 4.6% of children ages 12 to 19 were obese. By 2007-2008, 19.6% of children 6 to 11 years of age and 18.1% of children ages 12 to 19 were classified as obese. By 2011-2012, incidence of childhood obesity had further increased to 20.5% for 12 to 19 year olds (Centers for Disease Control and Prevention/National Center for Health Statistics [CDC/NCHS], 2014). Additionally, 10.4% of 2 to 5 year olds were classified as obese by the 2007-2008 period, more than double the 5% rate during 1971-1974 (Ogden & Carroll, 2010). Health studies show that childhood obesity tends to continue on into adulthood (Bouchard, 1997; Dietz, 1997), which makes it an increasing public health concern. Being overweight or obese is a major risk factor for other chronic diseases, including heart disease, hypertension, type 2 diabetes, stroke, and certain types of cancers. According to Wolf (2002, p. 58S), obesity has a "sizeable economic burden on the healthcare system"—the annual medical costs of obesity in the United States have been calculated at up to $147 billion as of 2008 (Finkelstein, Trogdon, Cohen, & Dietz, 2009). Being overweight or obese also has other direct and indirect social and economic consequences. Women who are overweight in young adulthood obtain less education and have lower incomes and a higher chance of being in poverty over their lifetimes (Gortmaker, Must, Perrin, Sobol, & Dietz, 1993). Obesity also lowers employee productivity (Wolf, 2002).

Obesity is a consequence of consuming more calories than are expended. There is no consensus on why an increasing proportion of children are over-consuming and under-utilizing calories. However, the explanation would seem to include maternal influences on the child. Not only are mother and child typically related genetically but often, especially at young ages, the mother controls access to food, supervises activities, and oversees socialization. Thus, it is plausible that mother-specific factors could be influencing this rise in child obesity. Two such factors will be considered here. A mother's weight status, could influence her child's weight status through both genetic and behavioral channels. Over the relevant time period, a mother's probability of being overweight or obese has risen. In the 1960-1962 period, 31.5% of adults aged 20-74 were considered overweight, but not obese, and 13.4% were considered obese. By 2007-2008, 33.6% of adults were classified as overweight, and 34.3% were classified as obese. For women specifically, 35.5% were considered obese in 2007-2008 (Ogden & Carroll, 2011).

The second factor hypothesized to play a role in increasing child obesity is the rising maternal labor force participation. The timing of the increase in maternal employment coincides with the rise in childhood overweight/obesity rates. From 1970 to 2008, the proportion of women in the labor force with children ages 6 to 17 increased from 49.2% to 76.2% for married women; from 66.9% to 81.5% for widowed, divorced, or separated women; and from 67.6% to 78.7% for single women. For mothers with children under age 6, the proportion in the labor force increased from 30.3% to

1. *Overweight and obesity are classified using body mass index (BMI), a measure of weight relative to height (found by dividing weight in kilograms by the square of height in meters). Adults with a BMI of 25 kg/m^2 or higher are defined as overweight, while adults with a BMI of 30.0 kg/m^2 or higher are defined as obese. In children, overweight is defined as having a BMI between the 85th and 95th percentile of a fixed distribution for the child's age and gender, while obese is defined as having a BMI greater than the 95th percentile of the same fixed distribution.*

61.6% for married women; from 52.2% to 73.9% for widowed, divorced, or separated women, and from 44.1% to 66% for single women (US Census Bureau, 2011).[2] Meanwhile, the share of children in single-parent homes has risen from 15% to 33%.

Literature Review

Given the trends in childhood obesity, obesity among adult women, and maternal employment, there is interest in examining whether the similarly-timed increases are more than coincidence. Thus, this article examines the relationship between childhood obesity and maternal employment and health in the United States. Specifically, this analysis focuses on the lesser-explored relationship between child obesity and mother's occupation choice and pre-pregnancy health.

Several studies in the United States have shown that mother's employment during a child's lifetime increases the child's likelihood of becoming overweight or obese. Using the US National Longitudinal Survey of Youth (NLSY), Liu, Hsiao, Matsumoto, and Chou (2009) found that a mother's full-time employment increases her child's likelihood of becoming overweight by 12.3%. Liu et al. examined several other possible contributing factors and found that a child's body mass index (BMI) is not significantly affected by having been breastfed, by having a father present in the household, or by place of residence (urban vs. rural). They did find that female and Hispanic children tend to have higher BMIs, while children with more highly educated mothers tend to have lower BMIs.

Others have shown that the probability of a child being overweight increases as the mother's hours worked per week increase. Anderson, Butcher, and Levine (2003) also employed the NLSY data and used it to examine the impact on a child's weight status of the child's mother working a greater number of weekly hours. They found that the probability of a child being overweight is significantly higher for mothers who work more hours per week (measured by a 10-hour increase in the average weekly hours worked). The relationship is most significant for the highest income quartile, for more educated mothers, and for white mothers; a highly-educated white mother in the highest income quartile who moves from part-time (20 hours per week) to full-time (40 hours per week) working status increases her child's likelihood of being overweight by 2.0 to 8.0 percentage points. They also showed that for families of higher socioeconomic status, between 12% and 35% of the increase in the proportion of children who are overweight since the 1970s is due to mothers working more hours per week.

Similarly, Ruhm (2008) used the NLSY data to investigate the impact of a mother's average working hours increasing on child obesity and on the risk of a child becoming overweight. He found that an additional 20 hours of employment per week for the mother increases her child's likelihood of obesity by 1.6 to 2.7 percentage points and increases the risk of becoming overweight by 3.0 to 4.5 percentage points. Given the overall proportion of children who are obese or at risk of becoming overweight within the sample, these estimates would imply that an additional 20 hours of weekly work time by a mother increases the probability of a child being obese by up to 20% and increases the risk of a child becoming overweight by up to 15%. Ruhm also examined the impact on cognitive development and found that "advantaged" adolescents (those from families with higher socioeconomic statuses) suffer more deleterious effects from increased material employment hours than do those adolescents from "disadvantaged" families.

Fertig, Glomm, and Tchernis (2009) used the Child Development Supplement of the Panel Study of Income Dynamics to analyze the impact of maternal working hours on child weight status. They found that the more hours a mother works, the greater the probability that her child is overweight. They also found that race (specifically being black or Hispanic) and the child's birth weight play a significant role in increasing the probability of the child being overweight. Among the factors that decrease the probability of the child being overweight are the child's age, if the child is female, and if the child was breastfed.

Several studies in the United States have determined that maternal health—specifically weight status—also impacts a child's weight status. Anderson et al. (2003) found that a mother's weight status has a large impact on child's weight status. They examined the impact of a mother being either overweight or obese (BMI $\geq$ 25) or strictly obese (BMI $\geq$ 30) and found that each status significantly impacts whether the child is overweight. Specifically, they found that a child whose mother is obese is 8.1% more likely to be overweight. Also using the NLSY data, Strauss and Knight (1999) found that children whose mothers are strictly overweight but not obese (25 $\leq$ BMI < 30) are 1.5 times as likely to suffer from childhood obesity. For children whose mothers are

2. *The figures for single mothers are from 1980 due to data limitations.*

obese (BMI ≥ 30), the risk of being obese is three times as great. Fertig et al. (2009) found that children whose mothers are obese (BMI > 30) have a 14.9% higher likelihood of being overweight. The effect is smaller (11.6%) for less-educated obese mothers and greater (18.4%) for more-educated obese mothers.

Research Objective

While previous work has shown that maternal employment increases the probability of a child being overweight or obese, it has not explained the link between a mother's employment and her child's health status. It is possible that the key lies in the nature of the mother's work and constraints on her time. If so, the mother's occupational choice and her child's obesity may be linked. Two physicians, Strauss and Knight (1999), examined the impact of a parent's broad occupational category: not employed, employed in a "nonprofessional" occupation, or employed in a "professional/managerial" occupation. They found that a child with a parent who is not employed or who is employed in a nonprofessional occupation is more likely to be obese than a child who has a parent in a professional occupation.

There are many possible ways that occupational choice could affect childhood obesity. Jobs requiring greater management of people or resources may lead to more working hours or more varied hours, disrupting or depleting time available for childcare or household production. More varied or less routine job tasks may distract planning activities in home production or child training. More physical demands on the job or greater levels of required customer service may tax physical or emotional strength needed for home production or child nurturing. On the other hand, some job requirements may be complementary to the types of skills needed to manage home and child affairs. This study will assess whether there are systematic differences in the incidence of child obesity related to the mother's choice of occupation.

The link between maternal health—specifically weight status—and child's weight status will also be explored. Several studies in the United States have shown a causal link between current maternal weight status and a child's weight status. The mother's pre-pregnancy weight status is a better measure than current weight status because the choices a mother may make before becoming pregnant with or having the child are different from those she may make once she is pregnant. This is particularly true if the mother's career choice affects her time allocation post-pregnancy. Because the mother's and child's current BMI are jointly determined by the mother's career choice, use of current maternal health will be subject to endogeneity bias.

Econometric Model Specification

Previous work on this topic (Anderson et al., 2003; Chia, 2008) used a model based on the specification of a child's weight. However, the dependent variable of interest here is whether a child is overweight or obese. As mentioned previously, this is determined by whether the child's BMI is above the relevant percentile cut-off for the child's gender and age, and the calculation of a child's BMI is based on his or her weight and height. The specification of the econometric model here then depends on the factors that determine a child's BMI (weight, height, age, and gender) since these are the direct determinants of whether a child is overweight or obese. Age and gender will be included in the econometric model, so the other variables of interest are those that determine weight and height. The factors that contribute to a child's height are almost entirely genetic, except in the case of extreme nutrient deprivation. Since the populations analyzed in this study are not suffering from such extreme nutrient deprivation, the factors that determine height will be assumed to be solely genetic.

The factors that contribute to a child's weight are those that affect the child's energy intake (or calorie consumption) and expenditure (or physical activity). Some of these factors are pre-determined through the child's genetics; these factors specifically control the child's basal energy expenditure.[3] The other factors are determined by the environment in which the child is being raised, which influences access to more or less healthy food sources (affecting calorie consumption) and outlets for or requirements of physical activity (affecting energy expenditure above BEE). The genetic factors determining both weight and height will be represented by maternal choices and characteristics before or during pregnancy and child characteristics at the time of the child's birth. The environmental factors also include maternal choices made around the time of pregnancy as well as current maternal choices and household characteristics. Two of the maternal choices/characteristics—maternal health and maternal occupation—are the primary independent variables of interest in this study.

3. *A person's basal energy expenditure (BEE) is the average amount of energy (measured in calories) burned by the body in a day when the body is entirely at rest.*

Selected Variables

The dependent variable used in this analysis will be an indicator variable of whether the child is obese. For every child in the sample with both valid weight and height data, BMI is computed and compared to the CDC growth charts for the appropriate child age and gender. Children with a BMI at or above the 95th percentile for their age and gender are classified as obese. For these children, the indicator variable takes a value of one; for all others, the indicator variable takes a value of zero.

The additional child variables used in the analysis will include the child's age, gender, indicators on child race/ethnicity (whether the child is black [non-Hispanic] or Hispanic), birth weight, whether the child was breastfed, and whether the child is the firstborn of the family. Previous studies (Anderson et al., 2003) have shown that black children are significantly more likely to be overweight than children of other races and that children who were breastfed are less likely to develop weight problems (Gillman et al., 2001; von Kries et al., 1999). It also seems reasonable that being the firstborn child in a family could affect a child's weight status. The firstborn child gets more individual attention before the possible addition of siblings, however, some mothers choose to return to work after having a first child but choose to remain out of the labor force upon having subsequent children.

Maternal characteristics will be included from the time surrounding pregnancy with the child or at the time of the child's birth, as well as at the time the child's weight status. These variables include alcohol or cigarette use during pregnancy and maternal age at the birth of the child, in addition to the mother's weight status before pregnancy. To determine mother's weight status, maternal BMI is calculated using height and body weight before pregnancy; mothers who have BMIs greater than 25 kg/m^2 are classified as overweight while mothers who have BMIs greater than 30 kg/m^2 are classified as obese. Other variables include the mother's education (by highest degree completed or highest level attained) and occupation at the time the child's weight status is measured. For most mothers, level of education will affect occupation, thus some of the occupational impact may be seen through the education variables. The occupation variable will be detailed below. Finally, the household characteristics will include whether there is a father figure present in the household, as well as if that father figure stays home and cares for the child while the mother is employed, family income, the region of the country in which the family resides and whether they live in an urban or rural setting.

Table 1. Occupation categories, from the American time-use survey.

1. Management
2. Business and financial operations
3. Computer and mathematical sciences
4. Architecture and engineering
5. Life, physical, and social sciences
6. Community and social services
7. Legal
8. Education, training, and library
9. Arts, design, entertainment, sports, and media
10. Healthcare practitioner and technical
11. Healthcare support
12. Protective service
13. Food preparation and serving
14. Building and grounds cleaning and maintenance
15. Personal care and service
16. Sales and related
17. Office and administrative support
18. Farming, fishing, and forestry
19. Construction and extraction
20. Installation, maintenance, and repair
21. Production
22. Transportation and material moving

The second of the two primary independent variables of interest—mother's career choice—will be represented through a series of occupation category indicator variables. The occupation categories will be defined as in the American Time Use Survey (ATUS), a federally-administered, nationally-representative survey providing data on the average time use of individuals in the United States. One of the variables available in the ATUS data is occupation by Census code, grouped into one of 22 categories. In order to ensure no category with too small a sample size and to provide more meaningful results around the occupation data, these 22 occupation categories have been grouped further into 13 categories. See Table 1 for the categories.

In addition to the occupation categories, dummy variables are created for mothers who are full-time homemakers and for mothers who are employed but for whom no occupation code is recorded. The dummy variables for the occupation categories plus the homemakers and the employed mothers with no coded occupation fully categorize all mothers in the sample. Thus, one of these groups must be excluded, as the control group.

The "homemaker" category will be used as the control group for occupation choice and will be excluded from the model estimations. This allows for comparison among the occupation groups as they relate to not being employed.

Data

The NLSY provides matched mother-child data perfect for this analysis. The NLSY is a sample of 12,686 US residents born between 1957 and 1964, of which 6,283 are women. Beginning in 1986, children born to and living with women in the NLSY sample have been surveyed biannually as well. The essential variables for this study are all included in the NLSY data. Occupation and industry (by Census code) are included in the mother's data; this allows for categorization by occupations across all mothers. The survey is also designed to capture this information for self-employed mothers or for those in non-traditional work arrangements.

The model will be fit to matched mother-child observations from the 2008 round of the NLSY. In 2008, 3,356 of the 3,975 women surveyed had children, with a total of 7,247 living children interviewed. However, by 2008, many of these children were "young adults," defined by the NLSY as age 16 or older. Since the primary interest of this study is the impact of maternal choices on the child's health, only the "children" (age 15 or younger) of the NLSY sample will be included; children who are 16 years of age or older have more control over their food intake and physical activity. In 2008, there were 1,347 "children" interviewed; however, 13 of these children were under two years old and are excluded because child weight distributions are first available at age two. Of the remaining 1,334 mother-child pairs, 464 are missing valid height or weight data (necessary to determine BMI) for the child (104 children) or the mother (360 children). One final pair is missing information on maternal alcohol use during pregnancy and is excluded to avoid problems of perfect prediction. The resulting working sample is 869 children aged 2-15.

Summary statistics for the sample are included in Table 2. In this sample, 22.6% of the children are obese and 39.0% are overweight (including obese). Child age ranges from 4 years 5 months to almost 15 years, with the average child age being just under 11 years old, and 48.6% of the children are girls. By race, 19.7% of children in the sample are Hispanic and 22.0% are black. In the entire NLSY population, 19.2% of the children are Hispanic and 27.7% are black, so anthropometric data was less reliably reported for black children. Sixty-nine percent of children were breastfed, similar to national data.[4] Breastfeeding intensity also was roughly comparable to national data: 10.2% of the children were breastfed for a month or less, 17.6% for one to three months, 16.2% for three to six months, and 25.4% for more than six months. Average birth weight for the children for whom it is reported (89.2% of the sample) is 7 pounds 6 ounces, and 28.1% of the children in the sample are firstborns.

For the maternal variables, 40.4% and 19.1% of children have mothers who used alcohol and cigarettes, respectively, during pregnancy. Mothers ranged from 29 to 44 years of age at birth of the child—34.7 years on average. The older-than-average maternal age at birth is due to the nature of the NLSY sample. All children in the sample were no older than 15 years of age in 2008, and all of the mothers in the sample were born between 1957 and 1964. Consequently, the youngest possible age for a mother at the time of birth is 27 years. Before pregnancy, maternal BMIs ranged from 16.0 kg/m^2 (for a mother who was 5'8" and 105 lbs.) to 85.8 kg/m^2 (for a mother who was 5'4" and 500 lbs.). The average pre-pregnancy maternal BMI was 25.6 kg/m^2, with 42.2% of mothers in the sample being overweight and 18.2% of the mothers being obese. By definition, the mothers who are obese are also overweight, so 24% of mothers are strictly overweight and not obese. The greatest proportion, 35.6%, of children have mothers who are high-school educated, while 15.3% have a mother with an Associate's degree, 23.9% have a mother with a Bachelor's degree, and 16.8% have a mother with a graduate degree; 1.5% of the children have a mother with a degree other than those listed.

Most children have two adults in the household, with 79.1% of the children having a male adult in the household in addition to the mother. For 87% of these children, the male adult is married to the mother. Most of the adult men in these households are working: only 5.9% of the children have an adult male in the household who is not employed. In the 2010 Census, 3.4% of stay-at-home parents were fathers (Harrington, Van Deusen, & Fraone, 2013). Average family income for the sample is $91,417, with quartile cut-offs at $32,000, $70,020, and $115,324.

4. *Breastfeeding rates were 70.9% in 2000 according to information from the CDC National Immunization Survey, available at: http://www.cdc.gov/breastfeeding/data/NIS_data/index.htm.*

Table 2. Summary statistics.

Variable	Obs	Mean	Std Dev	Min	Max
Child Obese	869	0.23	0.42	0	1
Child Overweight	869	0.39	0.49	0	1
ChildHeight (in inches)	869	56.92	7.46	19	74
ChildWeight (in pounds)	869	95.16	34.92	35	304
Child BMI (kg/m^2)	869	20.46	6.81	7.32	140.21
ChildAgeMos (in months)	869	131.35	26.59	53	178
ChildBirthWght (in ounces)	775	117.89	22.24	17	193
MotherWtBeforePreg (in pounds)	869	149.96	38.14	90	500
MotherHeight (in inches)	869	64.17	2.76	56	76
MotherBMIBeforePreg (kg/m^2)	869	25.60	6.27	15.96	85.82
MotherOverwtPrePreg	869	0.42	0.49	0	1
MotherObesePrePreg	869	0.18	0.39	0	1
MotherHSGrad	869	0.36	0.48	0	1
MotherAssocGrad	869	0.15	0.36	0	1
MotherCollegeGrad	869	0.24	0.43	0	1
MotherMastersGrad	869	0.14	0.34	0	1
MotherDoctorateGrad	869	0.03	0.18	0	1
MotherOtherEd	869	0.02	0.12	0	1
MaleAdultinHH	869	0.79	0.41	0	1
FamilyIncome	869	91,417	94,720	0	454,737
Urban	869	0.78	0.40	0	1
Occupation categories					
“Homemaker” occupation	869	0.17	0.38	0	1
1. Management	869	0.09	0.28	0	1
2, 7. Business/financial, legal	869	0.07	0.25	0	1
3, 4. Computer science/math, engineer	869	0.03	0.16	0	1
5, 8. Science, education	869	0.10	0.30	0	1
6, 11. Social services, health support	869	0.07	0.26	0	1
9. Art, entertainment, media	869	0.02	0.13	0	1
10. Health practitioner	869	0.06	0.23	0	1
12. Protective service	869	0.02	0.15	0	1
13, 15. Food prep, service	869	0.08	0.28	0	1
14, 18-20. Maintenance, construction	869	0.01	0.11	0	1
16. Sales	869	0.06	0.24	0	1
17. Office, admin support	869	0.14	0.35	0	1
21, 22. Product, transport	869	0.05	0.22	0	1
Other occupations	869	0.02	0.13	0	1

Homemakers comprise 17.4% of the sample; 13.6% are homemakers who also have a male adult in the household (11.6% with a spouse, 1.4% with a partner) and 3.8% are those who do not. The largest share of working mothers are in office and administrative support occupations, comprising 14.2% of the sample. The next most substantial occupations include education (10.4%); training and library (10.4%); life, physical, or social science occupations (10.4%); management occupations (8.6%); food preparation/serving-related or personal care/service occupations (8.4%); community/social service or healthcare support occupations (7.4%); and business/financial operations or legal occupations (6.7%). In this sample, there are 14 mothers, with a total of 16 children (for a total of 1.8% of the sample), that are employed but who did not report an occupation.

Employment proportions here are given relative to the entire sample. If, however, they were calculated relative to the number of women who are employed, the proportions in each occupation would clearly be higher.

Since the primary variable of interest in this analysis is mother's occupation choice, it is interesting to compare the descriptive statistics of the variables for mothers who are employed with those for mothers who are not employed. Many of the variables are similar between the two groups. Those that are noticeably different will be highlighted here. Most substantially, the rate of child obesity is higher within the homemaker group, with 12.1% more children being obese in the homemaker group than in the employed group. The proportion of children who are overweight but not obese is essentially identical between the two groups, but the measure for overweight (including obese) of course reflects the large difference in child obesity between the two groups. The children of homemakers are slightly younger on average (by about four months) which seems reasonable since many women re-enter the workforce as their children age into school. Mothers of Hispanic children are more likely to be homemakers, while mothers of black children are more likely to be employed. Surprisingly, breastfeeding rates are higher among employed women (by about 7.0%) and they tend to breastfeed their children longer. Homemakers in the sample used cigarettes at a higher rate during pregnancy (by 2.5%) than do employed women, but employed women tended to drink alcohol more during pregnancy (by 6.4%).

Importantly pre-pregnancy weight status is similar between the employed and non-employed mothers; thus, any differences in their children's BMI's will not be driven by differences in maternal health between the two groups. Homemakers in the sample are less educated; mothers with college or graduate degrees are more likely to work. However, average family income is slightly higher for homemakers, though more homemakers' families are in the first (lowest) income quartile. Finally, more mothers who are employed live in the North Central region, and more homemakers living in the South and West regions.

Estimation and Results

As discussed, the econometric model is fit with a probit on the dependent variable that the child is obese based on mother's occupation category and a variety of other child, maternal (including mother's pre-pregnancy weight status), and household characteristics. The homemaker occupation category is used as the control variable for the occupation categories. The marginal effects of the probit are presented in Table 3. As in previous results, black children are more likely (8.6%) to be obese. Obesity risk for children does not appear to significantly differ between genders. Child age is negatively correlated with obesity; aging a month results in a 0.36% decrease in obesity risk, while birth weight is positively correlated with obesity. For children for whom birth weight is reported, every additional ounce at birth is correlated with a 0.15% increase in obesity risk.

Neither a mother's age at birth of a child nor cigarette or alcohol use during pregnancy is shown to have a significant impact on child obesity later in childhood. However, including a mother's pre-pregnancy weight status proves to support previous results with an added dimension; recall that previous results have indicated that current overweight or obese status of a mother increases her child's risk for obesity. The findings here suggest a similar relationship between a mother's pre-pregnancy weight status and her child's likelihood of obesity. A mother being overweight or obese before she became pregnant with the child increases her child's probability of being obese by 7.2% and 10.8%, respectively. A mother obtaining more education has a beneficial effect on child health, and the more education the mother obtains, the more beneficial it is to the child's health. A mother having any education above high-school completion is associated with her child being at a lower risk of obesity, with the risk getting even lower as a mother obtains more education. A child of a mother with an Associate's degree is 6.0% less likely to be obese than a child of a mother with only a high-school education; for a Bachelor's, Master's, or Doctorate degree, the impact is strengthened to the risk dropping by 12.0%, 12.8%, or 14.4%, respectively, as compared to only a high-school education. Jointly, the education variables are found to be significant at the 5% level.

The presence of a male adult in the household (whether of spousal, partner, or "other" relationship) is significant and decreases a child's risk of obesity by 8.8%; whether that adult male is not employed is not significant. However, a joint test of significance of the two together shows them to be significant at the 5% level. The income variables are neither independently nor jointly significant. The region in which the family resides does not seem to have an impact on a child's risk of obesity, given the other controlling factors; however, residing in an urban area makes a child 6.9% less likely to be obese.

Table 3. Probit marginal effects of the impact of maternal occupation on whether child is obese.[a]

Variable	Obese	z-statistic	Variable	Obese	z-statistic
ChildAgeMos	-0.004***	(-4.27)	MaleAdultinHH	-0.088**	(-2.18)
FemaleChild	-0.010	(-0.37)	StayHomeDad	-0.069	(-1.16)
ChildHispanic	0.022	(0.54)	Urban	-0.069*	(-1.94)
ChildBlack	0.086**	(2.11)	**Occupations [c]**		
MissingBirthWght	0.185	(1.58)	Management	-0.041	(-0.77)
ChildBirthWght	0.001**	(2.09)	Business, financial, legal	-0.129**	(-2.33)
AlcoholDurPreg	-0.017	(-0.56)	CompSci/math, engineering	0.054	(0.57)
CigDurPreg	0.038	(0.99)	Science, education	-0.083	(-1.51)
MotherAgeBirth	-0.009	(-1.22)	Soc services, health support	-0.020	(-0.36)
MotherOverwtPreChild	0.072**	(2.11)	Art, entertainment, media	-0.147	(-1.47)
MotherObesePreChild	0.108**	(2.45)	Health practitioner	0.042	(0.61)
Education [b]			Protective service	-0.058	(-0.74)
MotherAssocGrad	-0.060*	(-1.65)	Food prep, service	-0.032	(-0.62)
MotherCollegeGrad	-0.120***	(-3.16)	Maintenance, construction	0.119	(0.93)
MotherMastersGrad	-0.128***	(-2.80)	Sales	-0.039	(-0.65)
MotherDoctorateGrad	-0.144**	(-1.98)	Office, admin support	-0.095**	(-2.24)
MotherOtherEd	-0.070	(-0.77)	Production, transportation	-0.129***	(-2.67)
			OccupationOther	0.111	(0.99)
Joint tests of significance: Chi^2 statistic given, with (Pr>Chi^2)in parentheses					
Occupations			24.3 (0.04)**		
Education			14.5 (0.01)**		
MaleAdult/employed			7.0 (0.03)**		
Pseudo R^2			0.19		
Number of observations			869		

, **, * Significant at the 10%, 5%, and 1% levels, respectively*

[a] Model also includes variables for length of time breastfed, whether firstborn, income quartile, and region of residence but none of these are significant determinants of child obesity

[b] Reference group for education is high school graduate or less, so education results are interpreted as the impact of that level of education relative to having completed high school or less

[c] Reference group for occupations is the Homemaker group, so occupation results are interpreted as the impact of being employed in that occupation relative to not being employed

Finally, the results on a mother's occupation turn out to be somewhat surprising. There are three significant combined occupation categories for mothers who are employed: occupation categories 2 and 7 (business and financial operations or legal occupations), occupation category 17 (office and administrative support occupations), and occupation categories 21 and 22 (production or transportation and material moving occupations). A mother being employed in an occupation in any of these categories actually decreases her child's risk of obesity—relative to children whose mothers are homemakers—by 12.9%, 9.5%, and 12.9%, respectively, for occupation categories 2 or 7, 17, and 21 or 22. The occupation results are jointly significant at the 5% level across all occupations.

Given the results on the occupations, an additional model is specified based only on employment status (employed versus not employed) as opposed to specific occupation. The included variables other than occupation remain the same. This specification shows that children of employed women are 6.9% less likely to be obese than children of mothers who are not employed. Within that model, the impacts of maternal pre-pregnancy weight status and whether there is an adult male in the household are slightly smaller, while the impacts of the child being black or living in an urban area are slightly larger. The effects of maternal education are slightly less at lower levels (Associate's or Bachelor's degrees) and slightly more at higher levels (Master's or Doctorate degrees); jointly, the impact of education is

Table 4. Relationship between O*NET occupation attributes and child obesity.

	Correlation coefficient [a]	Regression coefficient [b]	Regression t-stat	Regression P-value
Management	-0.23	-0.017	-1.40	0.161
Customer service	0.04	0.022	1.49	0.137
Time use	-0.25	-0.027**	-2.30	0.022
Physical nature	0.51	0.050***	3.88	0.000
Complementary skills	-0.14	-0.045***	-2.97	0.003
Support	0.10	0.020	1.10	0.273

, **, * Significant at the 10%, 5%, and 1% levels, respectively*

*[a] Correlation between occupation coefficients from the child obesity regression and occupation coefficients from the O*NET characteristics regression*

*[b] Coefficient from direct regression of the O*NET characteristics on child obesity*

larger. Additionally, whether the child's birth weight is not reported is now significant at the 10% level (in the original specification it is significant at about an 11.3% level); a child whose birth weight is not reported has a 19.4% higher risk of obesity. This would suggest that a mother not reporting or not remembering her child's birth weight is indicative of other inattentive behaviors with regard to child health.

Analysis of Maternal Occupation Characteristics

Since the relationship between maternal career choice and child obesity has not extensively been studied, the mechanisms that underlie this relationship are of interest. The Occupational Information Network (O*NET) developed by the US Department of Labor provides information on 277 occupation-specific traits for hundreds of occupations. The focus here will be on attributes hypothesized to matter to this relationship: management level of, customer service required of, time use within, and the physical nature of an occupation. Additionally, variables reflecting development of skills that are complementary to parenting or high levels of support within an occupation will also be analyzed. For the *management* aspects of an occupation, three key attributes are chosen from O*NET: importance of judgment and decision making, making decisions and solving problems, and speaking. For the *customer service* aspects of an occupation, three key attributes are chosen from O*NET: assisting and caring for others, dealing with unpleasant or angry people, and contact with others. For the *time use* aspects, five key attributes are chosen from O*NET: work schedules, duration of typical work week, electronic mail, importance of time management, and importance of time sharing. For the *physical nature* aspects, there are three key attributes: spending time walking and running; spending time kneeling, crouching, stooping, or crawling; and spending time bending or twisting the body. Finally, for the *complementary skills* aspects, there are three key attributes as well: active listening, training and teaching others, and importance of selective attention. The *support* aspect of an occupation has only one key attribute that measures whether the occupation has supportive management.

Principal components analysis is utilized to convert each of these sets of correlated variables into an aggregate measure for that category so that there is one measure for 'management,' one for 'customer service,' one for 'time use,' one for 'physicality,' and one for 'complementary skills.' Then the occupation categories are regressed individually on these aggregate measures as well as on the 'support' variable (which does not need to be aggregated since there is only one measure of support). This provides coefficients on the occupation categories that measure the occupations' impact on the O*NET attributes in addition to the previous coefficients on the occupation categories regarding their impact on child obesity. A simple correlation coefficient is calculated between the two sets of occupation coefficients—by O*NET attribute—to measure how much the specific occupation attributes may be influencing child obesity. Direct regressions of the O*NET attribute groups on child obesity are also examined in order to determine the significance of these correlations. The correlation coefficients and information from the direct regression are included in Table 4.

The regressions indicate highly significant relationships for the 'time use,' 'physical nature,' and 'complementary skills' aspects of the mother's occupation as they impact child obesity. The strongest relationship is found for the 'physical nature of the job,' with a correlation coefficient of 0.51; this indicates that the greater the

physical requirements of the mother's occupation, the greater the probability that the child will be obese. The 'time use' and 'complementary skills' categories of attributes are negatively correlated with the child's risk of obesity. The 'time use' category seems to indicate that it is a mother's ability to handle her time well that decreases the child's risk of obesity, as increases in the 'time use' category come from less regular work schedules, longer weekly hours, greater use of email, greater importance of time management, and less importance of time sharing (shifting among various tasks). Thus, despite the mother potentially working more or with less regularity, she is able to handle her work schedule such that it does not impact her child's health negatively. As expected, occupations with higher levels of attributes in the 'complementary skills' category impact child weight status in a favorable way. If the mother's occupation involves higher levels of active listening or training and teaching or has greater importance placed on selective attention, it is to the benefit of the child's health.

The attributes within the 'management and customer service' categories are less significant. The sign on the 'management' category correlation coefficient would suggest that occupations with more management aspects (importance of judgment, importance and level of decision-making, and level of speaking) are beneficial to the child's weight status. On the other hand, occupations with more customer service aspects (contact with others, assisting and caring for others, or dealing with unpleasant or angry people) are very slightly positively correlated with child obesity, but the relationship is negligible. There does not seem to be much of a relationship between the level of supportive management in the occupation and the child's risk of obesity. While the analysis of O*NET occupation attributes provides some insights into the impact of maternal occupation on child obesity, these results are primarily suggestive of underlying relationships. For the maternal occupations with beneficial impacts on the child's weight status, more work is needed to determine the specific attributes of these occupations that are disproportionately affecting children's health (in a positive way) through their mothers' employment in these fields.

Conclusion

These results provide more insight into factors contributing to the increases in childhood obesity in the United States. The two variables of primary interest in this study have significant results. As expected, mother's weight status prior to pregnancy plays an important role in determining a child's weight status. Children of mothers who were overweight or obese before becoming pregnant have a 7.2% higher chance of being obese. For women who were strictly obese before pregnancy, the increase in risk of obesity for the child climbs to 10.8%. The occupation results will be discussed shortly, but it is also worth noting here the significant impact of two additional variables. As the mother obtains more education, it has a beneficial (and relatively large) impact on her child(ren)'s health, decreasing the risk of obesity by 6.0% to 14.4%: the more education the mother obtains past high school, the greater the positive impact on the child's health. Secondly, having an adult male present in the household also has a favorable effect on the child's weight status, decreasing the risk of obesity by 8.8%.

Finally, the impact of maternal occupation on child obesity provides some interesting and even surprising results. Several occupations are shown to have significant impacts on child obesity, including, if the mother is employed in a business or financial operations or legal occupation, an office or administrative support occupation, or a production or transportation or material moving occupation. Previous research has found that maternal employment generally increases a child's probability of being obese. However, these results indicate that for a mother employed in any of these three occupation categories, her child(ren)'s risk of obesity declines, as compared to the mother not being employed. The mother being in a business or financial operations or legal occupation or a production or transportation or material moving occupation has the largest significant impact on a child's obesity risk (-12.9%), followed by being in an office or administrative support occupation (-9.5%). This would suggest that the increase in child obesity rates is not in fact due to women's rising labor force participation. As indicated by the specification with only employment status (employed versus not), a mother being employed actually reduces her child's likelihood of obesity by nearly 7% as compared to if the mother is not employed. These results support the findings of Strauss and Knight (1999), who found that a child of a parent who is not employed is more likely to be obese than a child who has a parent in a professional occupation.

It may be possible to create policy interventions that encourage and support some of these positive behavioral and lifestyle choices by mothers that decrease the likelihood of a child becoming obese. These behaviors or choices would include encouraging healthy pre-pregnancy weight statuses and higher levels of education of mothers, as well as two-parent households. As seen

through the O*NET occupation attributes, jobs that are very physical in their nature also increase the probability of child obesity. Thus, finding job-specific or employer-specific ways to mitigate these negative effects for very physical jobs would be beneficial for the children of mothers employed in these jobs.

Recall that these results are specific to children ages 2 to 15. So while maternal employment does not have a deleterious effect on child health for children older than two years, these results do not speak to the impact on younger children. Expanding these results to somehow capture the effect on younger children would be of interest. Other studies have shown that it would be beneficial for younger children specifically to have better parental leave policies in place. Berger, Hill, and Waldfogel (2005) found that when mothers return to work shortly after the birth of a child, it decreases child immunizations and doctor check-ups as well as breastfeeding duration. Ruhm (2000) and Tanaka (2005) both find that longer parental leaves lead to lower mortality rates among infants and young children.

Currently there is room for improvement in parental leave policies in the United States. Unlike in many other developed countries, mothers are not guaranteed any paid leave after the birth (or adoption) of a baby in the United States. Mothers are granted up to 12 weeks of unpaid leave through the Family Medical Leave Act (FMLA); however, in order to quality for FMLA, the mother must have been with her current employer for at least one year and the employer must have at least 50 workers within a 75 mile radius of the primary location. Only about 62% of the American workforce is thus covered by FMLA, and the proportion is substantially smaller at lower income levels (Ray, 2008). Comparing this to a country such as Canada in which mothers are guaranteed 52 weeks of maternity leave—with 29 weeks of the 52 being fully paid—suggests that the United States certainly is not competitive with regard to family leave policies. In fact, at 12 weeks of total available leave (if one qualifies for FMLA), the United States ranks last out of 21 Organization for Economic Co-operation and Development (OECD) countries in the amount of total leave provided to mothers and is one of only two high-income countries (Australia being the other) to not guarantee any paid leave (Ray, 2008). Other OECD countries range from 14 to 162 total weeks of leave, with between 11 and 42 of those weeks being paid leave. Additional research on the impact of family leave polices on both maternal employment and childhood obesity is necessary to develop a more comprehensive national leave policy that would help contribute to healthier children.

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