Childhood Obesity:
Does the Quality of Parental Time Matter?

George C. Davis
and
Wen You

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George C. Davis and Wen You are Professor and Assistant Professor at Virginia Tech University. Authorship is shared.

Contact Information: George C. Davis, georgedavis@vt.edu; Wen You, wenyou@vt.edu.

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Abstract

Childhood obesity is now considered an epidemic. Using a unique dataset, this study investigates the impact of engaged (to capture quality of time) and disengaged time of both mothers and fathers on the probability a child will be overweight for two age groups of children: 9-11 and 13-15. For the young age group we find mothers' engaged time with the child and fathers' engaged and disengaged time with the child are all important in terms of reducing the probability that the child being overweight. However, mothers' engaged time marginal effect does not appear to be significantly different from the marginal effect of disengaged time. Furthermore, while the marginal effect of fathers' engaged time is significantly different from the marginal effect of disengaged time, the marginal effect of disengaged time is an order of magnitude larger than that of engaged time. For the older age group we find that only mothers' disengaged time with the child is important in terms of reducing the child's overweight probability. Thus overall the quality of time, as measured by engaged time, does not seem to be marginally more important than just time with the child. Counterfactual examination reveals some interesting results: if parents of overweight children adapt the average parental time inputs of parents of normal weight children, ceteris paribus, the predicted probability of the children being overweight *decreases* by 15% and 11% for younger child group and older child group respectively. If fathers are completely uninvolved with their children, the probability of being overweight increases by an average of 116% across age groups. If mothers are completely uninvolved with their children, the probability of being overweight increases by an average of 98% across age groups.

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The sudden increase in childhood obesity in the United States is well documented. The percent of overweight children ages 2–5 in the United States has more than doubled since 1970 from 5% to 14%. For children ages 6–9 the number has almost tripled from 7% to 19% (Centers for Disease Control 2006). This trend is not confined to the United States. Similar patterns can be found around the globe in Australia, Brazil, China, Egypt, England, and Haiti, to name a few (Ebbeling, Pawlak, and Ludwig 2002). These trends are alarming because there are numerous health disorders associated with obesity (e.g., such as asthma, atherosclerosis, depression, hyperinsulinaemia, hypertension, sleep apena, and Type 2). Though many of these disorders were once thought to be limited to adults they are now appearing more frequently in children (Daniels 2006). Consequently, the economic cost associated with obesity is already high and expected to increase in the future. Finkelstein, Ruhm, and Kosa (2005) estimate that the direct and indirect cost in 2003 was in the neighborhood of $139 billion.

The causes of childhood obesity are manifold, but the changing environment appears to be the likely culprit (Egger and Swinburn 1997; Hill and Peters 1998; Hill, et al. 2003; Chou, Grossman, and Saffer 2004; Cutler, Glaser, and Shapiro 2003; Rashad 2006). For children, the most important environment is the home and parental time allocation is an obvious home environmental factor that may affect obesity rates. While there is a substantial literature on child developmental outcomes and parental time allocation, we are aware of only two articles that have considered obesity as an outcome. Using data from the National Longitudinal Survey of Youth in the United States, Anderson, Butcher, and Levine (ABL 2003) find that as the number of hours a mother works away from home increases, the probability that a child is overweight increases. One issue not considered by ABL (2003) is the impact a father's time in the work force will have on childhood obesity. Using data from the Statistics Canada National Longitudinal Survey of Children and Youth, Phipps, Lethridge, and Burton (PLB 2006) include both mothers' and fathers' work time in their analysis and find, similar to ABL (2003), that more maternal time (but *not* paternal) in the work force is associated with higher childhood obesity levels.

As ABL (2003) and PLB (2006) both indicate, parental work time could affect childhood obesity through several potential pathways and more research is required to understand these pathways. Indeed, the standard argument that maternal (and paternal) employment negatively impacts child outcomes is based on the implicit assumption that childcare time decreases as work time increases. However, more detailed time diary analysis (discussed below) indicates that this assumption is wrong and, in fact, working mothers have increased the amount of time spent in childcare over the last three decades. Furthermore, at any given point in time the time difference spent in childcare between employed mothers and unemployed mothers is mainly associated with what is termed "accessible" or disengaged time. This fact, coupled with the findings of ABL (2003) and PLB (2006) suggests the hypothesis that disengaged time may be more important in terms of obesity than engaged or 'quality' time for mothers. This hypothesis is contrary to the conventional wisdom that it is engaged or 'quality' time that is most important and though there have been calls to test this conventional hypothesis in general (Zick and Bryant 1996, p. 279) it has not been tested with respect to childhood obesity. This hypothesis and others will be tested here.

The purpose of this research is add to this fledgling literature by investigating the relationship between parental time spent directly with the child and child obesity in two interrelated dimensions: (i) by gender – mother's versus father's time with the child and (ii) by type of time – engaged time versus disengaged time with the child. Two different age groups of children are considered: 9–11 years of age and 13–15 years of age. Using a unique dataset we address several basic questions that have not been considered in the literature. For example, what is the marginal effect of a mother's (father's) engaged and disengaged time on the probability that a child will be obese? Are these marginal effects significantly different? What is the effect on the probability of being overweight if parental time inputs are altered? What is the effect on the probability of being overweight if the father (mother) is completely uninvolved with the child?

The next section gives a review of related literature. The following section gives the conceptual framework followed by a section describing the data collection and data used in the analysis. The results section is then given, followed by the conclusions.

Related Literature on Parental Time

Though there have been concerns that the increasing rate of labor force participation by women could have negative consequences for child development outcomes, the research results are at best mixed. In his 1984 Presidential address to the Population Association of America, Samuel Preston stated (Preston, 1984 p. 451), "[i]t is not all clear that mother's work is a source of disadvantage for children, at least not as a direct determinant. Recent reviews of studies of the effect of working mothers on child development find very few and inconsistent effects…" More recently, Bianchi (2000) and Zick, Bryant, and Osterbacka (2001) echo this conclusion.

The argument that an increase in work hours leads to less time in childcare and consequently a decline in healthy child outcomes rest on the implicit assumption that a mother's work time is inversely related to childcare time. In fact, childcare time is often calculated based on such an assumption. For example, in a Council of Economic Advisors report in 1999, childcare time was obtained from subtracting the total working hours from total waking hours. Using this 'residual' approach, it was calculated that parent's time in childcare had decreased by 22 hours per week between 1969 and 1999. This residual approach is a crude indirect measure and much of the empirical literature has focused on defining and measuring childcare time directly. Using more comprehensive and direct measures of childcare, the literature has focused on two related issues: (i) the measurement of childcare time and (ii) the substitution across activities.

With respect to measurement, research has demonstrated that the most accurate measure of time use comes from time diaries (Juster 1985). The standard format of a time diary is to ask three types of questions of the individual: what was the primary activity during this time period? What was the secondary activity during this time period? Who else was with you during this activity? From these three questions there are then numerous ways childcare time can be defined. Consequently, there is no uniform standard for measuring childcare time; rather different studies construct different measures at different levels of aggregation depending on the objective of the study. For example, some studies focus on several disaggregate primary activities that involve the parent and the child (e.g., Nock and Kingston 1988; Sayer, Bianchi, and Robinson 2001), while others include selected disaggregate primary and secondary activities involving the parent and child (e.g., Bryant and Zick 1996). Still others will create more aggregate measures of childcare time, such as grouping all childcare activities into either a primary childcare or a secondary childcare category (Zick and Bryan 1996), or into “engaged time” and “accessible time” (Sandberg and Hofferth 2001), or into “passive time” and “active time” (Folbre, Yoon, Finnoff, and Fuligini 2005). These differences in definitions and methods make it difficult to summarize and compare results across studies without numerous caveats. However, the general pattern appears to be that maternal employment has *not* decreased the amount of time parents spend in childcare. Rather, the amount of parental time in childcare for employed parents (mothers and fathers) appears to have increased over time as women have entered the labor force (e.g., Bianchi 2000; Sandberg and Hofferth 2001; Sayer, Bianchi and Robinson 2004).

How can an increase in work time also correspond with an increase in childcare time? Given there are different types of activities that constitute childcare, there are then several types of substitution patterns that can explain this puzzle. Consider a simple accounting identity for time allocation for each parent across three broad activities – work, childcare, and other:

$$(1)\quad T = T_w^i + T_{cc}^i + T_o^i$$

$$= T_w^i + \sum_{j \in T_{cc}^i} t_j^i + \sum_{k \in T_o^i} t_k^i \qquad i = Mother, Father.$$

where T is total available time say in a week, T_w^i is time at work, T_{cc}^i is total time in childcare, and T_o^i is total time in other activities. The ‘residual’ or employment method assumes the level of aggregation in the first line and that all childcare time is equal (i.e., 10 minutes at the doctor equals 10 minutes playing Monopoly). Assuming T_o^i is constant, if time in work T_w^i

increases, time in childcare T_{cc}^{i} must decrease. However, the second line of equation (1) captures more accurately the idea that there are many activities that can qualify as childcare (e.g., helping with homework, playing a game). Using equation (1), the total amount of childcare time for both parents is then

$$(2)\quad T_{cc} = T_{cc}^{M} + T_{cc}^{F} = \sum_{j \in T_{cc}^{i}} t_{j}^{M} + \sum_{j \in T_{cc}^{i}} t_{j}^{F} = 2T - (T_{w}^{M} + T_{w}^{F}) - \sum_{k \in T_{o}^{i}} t_{k}^{M} - \sum_{k \in T_{o}^{i}} t_{k}^{F}.$$

Equation (2) indicates that childcare time can be held constant or even increased by two general types of substitution. First, there may be *intra–gender substitution* between activities: a parent may substitute more childcare time for less personal leisure time if time is tight. Second, there may be *inter-gender substitution* between parents: a father may come home early from work to watch the kids if the mother cannot get off at her normal time or vice-versa. In addition, childcare time can always be increased by *joint production* if children are involved with a parent in secondary activities (e.g., preparing dinner while helping a child with homework versus just preparing dinner). Joint production and intra- and inter-gender substitution possibilities give parents a great deal of flexibility in compensating for increased work loads and the literature cited finds one or all of these factors coming into play to compensate for increased work loads. In particular, though unemployed mothers do spend more time with their children than employed mothers, most of the difference in time is in disengaged not engaged time (e.g., Bianchi 2000; Bryant and Zick 1996; Nock and Kingston 1988; Zick and Bryant 1996). Also, fathers appear to be spending more time with children as mother employment rates have increased (e.g., Bianchi 2000; Sandberg and Hofferth 2001; Sayer, Bianchi, and Robinson 2004; Yeung, et al. 2001). All of this suggests that in analyzing the effect of parental childcare time on the probability of obesity it is important to measure parental childcare directly in two different dimensions: (i) by gender –

mother's versus father's time with the child, (ii) by type of time – engaged time versus disengaged time with the child.

Conceptual Framework

The standard framework for looking at child health outcomes is within a production function context where the inputs are parental choice variables (e.g., Berman, Kendall, and Bhattacharyya 1994; Rosenzweig and Schultz 1983).[1] Because the interest here is in the direct effects of the mother's and father's engaged and disengaged time on obesity, as measured by the child's body mass index (BMI), the focus here is on the production function. In its general form, the production function can be written as

$$(3) \quad B = B(T_E^M, T_E^F, T_D^M, T_D^F, \boldsymbol{X}; \boldsymbol{E}),$$

where B is the child's body mass index, which is weight in kilograms divided by the square of height in meters, T_E^i and T_D^i denote engaged time and disengaged time with the child, respectively, for parent i= **M**other, **F**ather, $\boldsymbol{X}$ denotes a vector of other inputs, such as available food, and $\boldsymbol{E}$ is a vector of environmental variables. This production function can be motivated by either considering the child as having no decision power (Becker 1991) or having some decision input (Burton, Phipps, and Curtis 2002) as outlined in the appendix.

The implicit assumption made in this production function is the same as made in the child development literature: the more time a parent spends with the child, the child's health outcome (BMI) will approach some healthy (lower) limit. Conversely, the less time a parent spends with the child, the child's BMI will approach some unhealthy (upper) limit. The marginal products with respect to the time variables are therefore all expected to be negative, $MP_{T_j^i} = \frac{\partial B}{\partial T_j^i} < 0$ for any $i = M, F$ and $j = E, D$. Though these marginal products are all expected to be negative, they are not expected to be equal. For example, if there are diminishing returns and the amount of engaged time with the child is much greater than the amount of disengaged time, then the marginal product of disengaged time could be *greater* than the marginal product of engaged time. This of course does not mean the total product with respect to engaged time is less than that of disengaged time. Similar arguments can be made across gender but within time type: there is no reason to expect the marginal product of a mother's time with the child to be the same as a father's time with the child.

The vector of variables capturing the home environment ***E*** warrant some discussion. For children, obesity is influenced to a large extent by the environment created by their parents, as is now widely documented (e.g., Barlow and Dietz 1998; Bourcier, et al. 2003; Hoffman and Sawaya 1999; Nicklas, et al 2001; Patrick and Nicklas 2005). The environmental variables can be categorized into three overlapping sets: economic, social-psychological, and biological.

The economic environmental vector consists of bargaining power variables between the parents ***P***. There is now a substantial literature demonstrating that when mothers control more of the resources and have more bargaining power, children's outcomes are improved (e.g., Blumberg 1988; Haddad and Hoddinott 1994; Maitra 2004; Presser 2003; Thomas 1990, 1994). This result has become known as the "good mother hypothesis" (Dooley, Lipman, and Stewart 2005) or "Kids-do-better hypothesis" (Lundberg and Pollak 1996 pp. 154-155).[2] While economists have focused on who controls the resources or the "resource theory" of power, there are actually numerous theories of power (see Cromwell and Olson 1975, chapter one). In the food sphere, Gregory (1999) indicates that it is the decision power over the activity that is important not whether or not they do the activity. For example, a wife may prepare meals but if her husband has power over what meals to prepare then that does not mean the meals prepared – though they are prepared by the mother – reflect the mother's priorities. Thus we would expect based on the "kids-do-better" hypothesis that as mothers have more control of food expenditures then the health of the child may be better.

The social psychological environmental vector consists of variables related to measuring stress in the home ***S*** because there is an extensive literature relating work stress to poor eating (e.g., "comfort foods"), exercise, and consequently poor health outcomes in adults and children (e.g., Baker 1985; Cartwright, et al. 2003; Devine, et al. 2003; Greeno and Wing 1994; Grywacz 2000; Hellerstedt and Jeffry 1997; Karlsson, Knuttson, and Lindahl 2001; Kouvonen, et al. 2005; McCann, Warnick and Knopp 1990; Menaghan 1991; Netterstrom et al. 1991; Nishitani and Sakakibara 2006; Rau and Triemer 2004; Schnall, et al. 1990; and Zellner, et al. 2006.) There is also literature relating parental eating and exercise practices to the health status of their child (e.g., Davison, Francis, and Birch 2005). While PLB (2006 p. 984) speculated that stress may contribute to obesity, they did not include any direct measure of stress as we will do in this study.

As Hoffman and Sawaya (1999) indicate, the efficiency with which food consumption and exercise are converted to weight is affected by biological and environmental factors, such as age, gender, puberty status, genetic factors, and stress, as has been documented in the literature (Agras et al. 2004; Crossman, Sullivan, and Benin 2006; Daniels et al. 1999; Laitinen, Power, and Jarvelein 2001; Salbe et al. 2002). The vector of biological/genetic variables is denoted by $\boldsymbol{\mu}$. The production function (3) can therefore be rewritten as

$$(4) \quad B = B(T_E^M, T_E^F, T_D^M, T_D^F, \boldsymbol{X}, \boldsymbol{P}, \boldsymbol{S}, \boldsymbol{\mu}) .$$

The next section discusses the data collected and variables used to represent the variables in equation (4) along with their summary statistics.

Data Collection and Variables

Unfortunately, no national datasets have a rich enough variety of variables to investigate the hypotheses of interest in this paper.[3] Because of this "variable scarcity" problem, as Haveman and Wolfe (1995, p. 1874) call it, no single study has been able to consider simultaneously the relationship between the covariates identified above and childhood obesity. Consequently, we collected our own data for this research.

Data Collection

Data were collected from 311 families in the Houston MSA and collected from each parent and one child. Measures of all covariates given above were collected. Based on the nutrition literature, two age groups of children were considered: 9–11 and 13–15. Twelve year old children are omitted because this is the most common age where there are drastic changes in height and weight associated with puberty. However, a measure of sexual maturity is included for each child in our analysis. Participants were recruited by means of random digit dialing. The sample size was selected based on the statistical power it provided for multivariate models with medium effect sizes.

Each parent completed three survey instruments. Socioeconomic information was collected mainly on the work/home environment such as work hours, work schedule, work stress; along with basic demographic information through a *telephone survey*. Income and expenditure information, along with decision power information on purchases and expenditures was collected from a *self-administered survey*. All activities each parent did for two consecutive days were recorded with a *2-day time diary*. The structure of the time diary was the same as used by the Bureau of Labor Statistics in the American Time Use Survey and provided the following information *from each parent for 2-days*: the date, the day, the beginning military time of the activity, the ending military time of the activity, the primary activity, the secondary activity, the place where the activity took place, and who else was with the individual. All activities were assigned codes and there are a total of 208 activities for fathers and 224 for mothers. Figure 1 gives an example page from a time diary.

For each household, one child 9–11 or 13–15 completed three survey instruments within the home. Information on the home environment such as parenting style, exercise, eating habits, and family meal rituals, along with basic demographic information was collected with a *personal interview*. Height and weight were measured as part of a *physical exam*. Self-reported height and weight are known to give biased BMI measurements (e.g. Phipps, et al. 2004), so we avoid that bias by the physical exam. Height was measured to the nearest 1/8 inch using a non-stretchable metal tape measure and a metal triangle while the subject was wearing lightweight clothing, no shoes, and standing on a non-carpeted surface. Weight was measured to the nearest .5 pound using a 12” by 12” 500 pound parcel scale. A sexual maturity measure was obtained from each child using *Tanner drawings* (e.g., Daniels, et al 1999).[4] All information from the child was collected in the home by a trained field interviewer. All questionnaires were also translated into Spanish for those who preferred to be interviewed in Spanish. Each child, mother, and father was paid $25, $20, and $15 respectively to participate.

Variables

The variable names used in the analysis along with their definitions are listed in table 1. Given the focus of the study, we will only briefly mention most variables and focus attention on describing how time with the child is measured.

Each child's body mass index (*BMI*) is measured as weight in kilograms/(height in meters)^2. Similar to ABL (2003) and PLB (2006), the age-gender adjusted BMI cutoffs for being overweight are defined using information from the Centers for Disease Control (CDC). A binary variable *Overweight* is 1 if the child's age-gender adjusted BMI percentile is at or above 85th percentile, indicating the child is at risk for overweight or overweight. If the percentile is between the 5th percentile and the 85th percentile, indicating the child is in the "healthy weight" range, *Overweight* is 0. [5]

From the parent's time diary a measure of engaged time with the child for each parent (*MothET*, *FathET*) and a measure of disengaged time with the child for each parent (*MothDET*, *FathDET*) is created. Engaged time is considered to be a measure of 'quality' time with the child. Because the time diary asks about primary and secondary activities and who was helping you, there are several possibilities for engaged or disengaged time, depending on if the child is helping. Our procedure is similar to that of Sandberg and Hofferth (2001) and the flow chart given in figure 2 shows the process for classifying time as engaged or disengaged.

Engaged time is created by adding together two types of engaged time: "engaged1" and "engaged2." If the primary activity the parent list is child related with direct interaction, then it is coded "engaged1." For example, if the parent reports playing with the child as the primary activity for an hour on a day, then there will be 60 minutes of "engaged1" activity for that parent for the day. If the primary activity is not child related with direct interaction, then we check if the child is listed as helping with the activity. If there is a secondary activity listed that is not child related with direct interaction, then this is coded "engaged2". The assumption with "engaged2" is that the child is helping with the primary activity not the secondary activity. For example, if the parent reports cooking dinner as the primary activity and watching TV as the secondary activity for 30 minutes and reports the child is helping, it is assumed the child is helping with the cooking. Engaged time for the parent is then defined as the sum of "engaged1" and "engaged2" (e.g., *MothET* = *Moth* (engaged1) + *Moth* (engaged2)).

Disengaged time is created by adding together two types of disengaged time: "disengaged1" and "disengaged2." If the primary activity is not child related with direct interaction, we then consider if the child is helping. If the child is helping and there is a secondary activity listed that is child related with direct interaction then it is coded "disengaged1." The assumption with "disengaged1" is that the child is helping with the secondary activity not the primary activity because the secondary activity is a child related activity. It is disengaged because it is not the parent's primary activity. For example, if the parent reports reading the paper as the primary activity, helping with homework as the secondary activity, and reports the child as helping this time is disengaged time. If the primary activity is not child related with direct interaction and the child is not listed as helping, we then consider the secondary activity. If the secondary activity is child related and the child is directly involved then it is coded as "disengaged2." As before, it is disengaged because it is not the parent's primary activity. For example, the parent reports cooking dinner as the primary activity while reporting watching TV with their child as the secondary activity and no child reported helping. Disengaged time for the parent is then defined as the sum of "disengaged1" and "disengaged2" (e.g., *MothDT* = *Moth*(disengaged1) + *Moth*(disengaged2)).

Three variables are related to food purchases. *FoodExp* is the average monthly household food expenditures measured in dollars. *FoodBuy* is a measure of the father's decision power relative to the mother's decision power in "whether to buy groceries." As *FoodBuy* increases, the father has more decision power in the Buy/No Buy groceries decision. Similarly, *FoodSpend* is a measure of the father's decision power relative to the mother's decision power in "how much to spend on groceries." As *FoodSpend* increases, the father has more decision power on how much to spend on groceries. *ParentsEd* is an indicator of the total number of grades both parents completed.

There are five social environmental variables. *SibNum* is the number of siblings present in the home. *MothExer* is the amount of time per day that the mother spends in some type of exercise activity without the child being directly engaged in the activity. *FathExer* is similarly defined and measured. *MothSpill* is a measure of the amount of spillover the mother experiences from her job to her home. This variable is a factor generated from a factor analysis on the responses to a set of questions developed by Simon (1992) to measure spillover. As the value of the *MothSpill* increases, the amount of spillover from work to home increases. *FathSpill* is similarly defined and measured.

There are five biological/genetic variables. *Puberty* is a dummy variable set to 1 if the child is considered pubescent and set to 0 if the child is considered pre-pubescent, based on the Tanner scale. *Gender* is a dummy variable indicating if the child is male (1) or female (0) and *White* is a dummy variable indicating if the child is Caucasian (1) or non-Caucasian

(0). Each parent's own body mass index is included as well and is measured as weight in kilograms/(height in meters)^2 (i.e., *MothBMI*, *FathBMI*)

Summary Statistics and Probit Results for 9-11 Age Group

The analysis is broken down by age group. While this reduces the number of observations available, it will become apparent that these are very different populations and it would be misleading to pool these two age groups. To get a sense of the differences in the two age groups we start with some casual empiricism by considering the basic summary statistics and correlations before turning to the probit analysis.

Summary Statistics

Table 2 gives the summary statistics for the 9-11 age group by the classification variable *Overweight*. The summary statistics are surprisingly consistent in general with a statistically naïve *a priori* ceteris paribus intuition. That is, the healthy weight group of children ($Healthy \equiv Overweight = 0$) spend more time with their parents and have a healthier home environment than those in the overweight group ($Overweight = 1$).

Specifically, there are a total of 114 children and 38% are overweight. Mothers' engaged time with the child averages about 4.40 hrs./day for the healthy weight group ($MothET_{healthy}$ = 263.56 mins./day) and is about 40 mins./day more on average than that of mothers in the overweight group ($MothET_{overweight}$ = 225.40 mins./day). The difference is even greater for fathers. Fathers' engaged time (with the child) averages about 3.40 hrs./day for the healthy weight group ($FathET_{healthy}$ = 201.32 mins./day) and is about 1.56 hrs./day more on average than for fathers in the overweight group ($FathET_{overweight}$ = 107.91 mins./day). In terms of disengaged time, there is very little difference between the amount of time the mothers spend with their child between the two groups (i.e., $MothDT_{healthy} – MothDT_{overweight}$ = 49.27 – 52.67 = –3.40 minutes/day). The difference in fathers' disengaged time with the child between the two groups is not large, but fathers in the healthy weight group spend about 9 minutes more on average in disengaged activities with the child than fathers in the overweight group (i.e., $FathDT_{healthy} – FathDT_{overweight}$ = 30.86 – 21.88 = 8.98 minutes/day).

The average monthly expenditures on food are greater for the overweight group ($FoodExp_{overweight}$ = \$709.95) than for the healthy weight group ($FoodExp_{healthy}$ = \$654.71). Mothers have less decision power in terms of the groceries "buy" and "spending" decision for the overweight group than the healthy weight group, given these indices have larger values for the overweight group (i.e., $FoodBuy_{healthy}$ = .11 *v*. $FoodBuy_{overweight}$ = .27 and $FoodSpend_{healthy}$ = .14 *v*. $FoodSpend_{overweight}$ = .32). There are also more siblings associated with the overweight group on average ($SibNum_{overweight}$ = 1.18) than the healthy weight group ($SibNum_{healthy}$ = 1). Fathers exercise about 7 minutes more per day in the healthy weight group than in the overweight group ($FathExer_{healthy}$ = 33.70 mins./day *v*. $FathExer_{overweight}$ = 26.73), but mothers exercise a little less in the healthy group than in the overweight group ($MothExer_{healthy}$ = 11.31 mins./day *v*. $MothExer_{overweight}$ = 13.63). There is also more work-to-home spillover for both parents in the overweight group than in the healthy weight group, as these indices have larger values for the overweight group (i.e., $MothSpill_{healthy}$ = 1.87 *v*. $MothSpill_{overweight}$ = 2.39 and $FathSpill_{healthy}$ = 1.85 *v*. $FathSpill_{overweight}$ = 2.09). In the healthy weight group 69% of the children are classified as pubescent (i.e. *Puberty*), whereas 86% of the children in the overweight group are classified as pubescent. The healthy weight group consists of 80% whites and the overweight group consists of 64% whites. The mothers' and fathers' body mass index are on average higher in the overweight group ($MothBMI_{overweight}$ =

26.80, $FathBMI_{overweight}$ = 28.53) than in the healthy weight group ($MothBMI_{healthy}$ = 23.48, $FathBMI_{healthy}$ = 26.40).

Before turning directly to the Probit results, table 3 gives the simple bivariate correlations between the child's BMI and the continuous covariates.[6] While there are certainly interpretations issue to keep in mind here (e.g., other variables are not held constant), the basic correlations are unconditional and provide a less sophisticated but complementary and less data demanding view of the relationship between variables. Somewhat surprisingly, many of the simple bivariate correlations accord with a ceteris paribus intuition at least in sign.

Table 3 shows that all of the parental measures of time spent with children are negatively correlated with *BMI* satisfying intuition. Fathers' engaged time has the largest negative correlation (*FathET* = –.19), followed by mothers' engaged time (*MothET* = –.08), fathers' disengaged time (*FathDT* = –.07), and mothers' disengaged (*MothDT* = –.03). However, only fathers' engaged time is significantly different from zero at the .05 significance level. Other variables that are negatively correlated with *BMI* are average monthly food expenditures (*FoodExp* = –.08), parents' education level (*ParentED* = –.26), fathers' exercise time (*FathExer* = –.11), fathers' work-home spillover (*FathSpill* = –.03). Of these variables, only parents' education level is significant at the .05 significance level. The variables that are positively correlated with *BMI* are father-relative-to-mother decision power in the grocery purchase decision (*FoodBuy* = .02) and the grocery expenditure decision (*FoodSpend* = .11), the number of siblings (*SibNum* = .25), mothers' exercise time (*MothExer* = .02), mothers' work-home spillover (*MothSpill* = .23), and both parents' BMIs (*MothBMI* = .46, *FathBMI* = .19). Of these, *SibNum*, *MothSpill*, *MothBMI*, and *FathBMI* are significant at the .05 significance level. So in summary, of these 15 variables, 11 have signs that would be expected without much thought. The four that are not very intuitive are the three negative correlations between *BMI* and *FoodExp, ParentED*, and *FathSpill* and the positive correlation between *BMI* and *MothExer*. Overall these results are intuitive and encouraging but they can be rather misleading in terms of signs and significance as they do not hold other variables constant. As a result, we turn to the probit analysis.

Probit Results

In this section we briefly present the results from a probit model but focus on the marginal effects of the parents' time with the child on the child's probability of being overweight. Because there are two dimensions of time (engaged *v.* disengaged and Mother *v*. Father), we test for significant differences in the marginal effects across both dimensions. In addition, we exam the changes of predicted probability of the child being overweight in different parental time input levels.

Before estimating the regular probit model, we first checked for endogeneity of the parents' time with the child (*MothET, FathET, MothDT*, *FathDT*), exercise time (*MothExer*, *FathExer*) and monthly food expenditures (*FoodExp*). All other variables in the model were used as instruments as well as the mother's and father's annual unearned income, answers to questions from the parents on job flexibility, job commitment, job responsibility, how active each parent considered themselves to be, the square of education, and the square of siblings. The estimation and testing were all done using the *ivprobit* command in STATA, which is the Newey (1987) minimum chi-square estimator and the test statistic for exogeneity is a Wald statistic. The test for exogeneity had a p-value of .39 so we proceeded with ordinary probit estimation.

Table 4 gives the probit results with the marginal effects for each variable and its corresponding *p*-value. Robust standard errors are used and efficiency is improved by exploiting the cluster properties of the data (i.e., each household has two observations – one for each time diary day). The pseudo R^2 of .51 is relatively high for cross-sectional data. Of the 18 variables, 12 are significant at the .10 significance level, with 11 significant at the .05 significance level. Discussion is limited to those variables that are statistically significant.

Table 4 shows that 3 of the 4 parental measures of time spent with children have significant negative marginal effects on the probability that the child is overweight. Fathers' disengaged time has the largest marginal effect (*FathDT* = –.004), followed by fathers' engaged time (*FathET* = –.0008), and then mothers' engaged time (*MothET* = –.0005). For every additional hour a father spends in disengaged time with the child, the probability that the child is overweight decreases by .24 (–.24 = –.004×60), *ceteris paribus*. These relative magnitudes may be surprising but they are consistent with diminishing returns to these inputs in general. That is, in terms of average time spent with the child, the rankings are fathers' disengaged time ($\overline{FDT} = 27$ mins/day), fathers' engaged time ($\overline{FET} = 165$ mins/day) and mothers' engaged time($\overline{MET} = 249$ mins/day), though of course the 'marginal product' functions are different for each parent and time activity.

The other significant variables in the model with positive marginal effects are the grocery purchase decision variable (*FoodBuy* = .38), mothers' exercise time (*MothExer* = .003), mothers' work-home spillover (*MothSpill* = .56), the child being pubescent (*Puberty* = .23), the child being male (*Gender* = .47), the mothers' BMI (*MothBMI* = .06), and the fathers' BMI (*FathBMI* = .07). The grocery expenditure decision variable and fathers' exercise time are both statistically significant and have negative marginal effects (i.e., *FoodSpend* = –.24, *FathExer* = –.002). Of these 9 marginal effects, only 2 have signs that are not expected a priori. Given the "Good-Mother-Hypothesis", and the way the grocery purchase decision variable is defined (i.e., increasing indicates the father has more decision power), it was expected that *FoodBuy* would have a negative marginal effect. Similarly, it was expected a priori that a mother exercising models good health habits for the child and so the expected marginal effect was expected to be negative for *MothExer*. While several legitimate ex post theories could be postulated to explain these unexpected signs, these variables are not the focus of the analysis, so attention turns to a more detailed consideration of the time variables.

Table 5 gives a matrix of marginal effects and the differences in marginal effects for the time variables of the parents. Statistical significance is indicated by asterisks. The diagonal elements just repeat the marginal effects that were given in table 4 for the time variables. The off diagonal elements are the difference between the marginal effect labeled by the column and the marginal effect labeled by the row. For example, the marginal effect for mothers' engaged time (*MothET*) is –0.0005 and for fathers' engaged time (*FathET*) is –0.0008. The difference in these two marginal effects is given in the second row, first column (*FathET*, *MothET*) and is 0.0003. Table 5 reveals that the marginal effects for mothers' engaged time (*MothET*), fathers' engaged time (*FathET*), and mothers' disengaged time (*MothDT*) are not statistically different. This implies that in terms of reducing the probability of childhood obesity, all these different time categories could be pooled. However, this result does not hold for fathers' disengaged time (*FathDT*). The statistically different marginal effects all involve the fathers' disengaged time. Given the fathers' disengaged marginal effect is –.004 and an order of magnitude greater than the other effects, then all of these significant differences are basically of the same magnitude .0003. Thus for this sample, just the presence of a father via disengage time makes a statistically significant difference.

Summary Statistics and Probit Results for 13–15 Age Group

This section presents the results for the 13–15 age group. Again, basic summary statistics and correlations are presented first, followed by the probit analysis. As will become apparent, the 13–15 age group results are very different from the 9–11 age group.

Summary Statistics

Table 6 gives the summary statistics for the 13–15 age group by the classification variable *Overweight*. There are a total of 130 children and 31% are overweight. For the healthy weight group, mothers' engaged time with the child averages about 2.83 hrs./day ($MothET_{healthy}$ = 170.66 mins./day) and is about 1 hr./day *less* on average than that of mothers in the overweight group ($MothET_{overweight}$ = 224.78 mins./day). The difference is comparable for fathers. Fathers' engaged time averages about 1.83 hrs./day for the healthy weight group ($FathET_{healthy}$ = 109.98 mins./day) and is about 1.27 hrs./day *less* on average than for fathers in the overweight group ($FathET_{overweight}$ = 186.11 mins./day). In terms of disengaged time, there is a difference of about 15 mins./day between mothers in the healthy weight group ($MothDT_{healthy}$ = 47.75 mins./day) and mothers in the overweight group ($MothDT_{overweight}$ = 32.88 minutes/day). The difference in fathers' disengaged time with the child between the two groups is not large on average – about 4 mins./day ($FathDT_{healthy} - FathDT_{overweight}$ = 34.66 – 38.85 = –4.20 mins./day).

The average monthly expenditures on food are less for the overweight group ($FoodExp_{overweight}$ = \$691.38) than for the healthy weight group ($FoodExp_{healthy}$ = \$730.79).

Mothers have more decision power in terms of the groceries "buy" and "spending" decision for the overweight group than the healthy weight group (i.e., $FoodBuy_{healthy}$ = 0.36 *v*. $FoodBuy_{overweight}$ = 0.00 and $FoodSpend_{healthy}$ = 0.33 *v*. $FoodSpend_{overweight}$ = 0.20). There are more siblings associated with the overweight group on average ($SibNum_{overweight}$ = 1.25) than the healthy weight group ($SibNum_{healthy}$ = .82). Fathers exercise about 20 minutes more per day in the healthy weight group than in the overweight group ($FathExer_{healthy}$ = 28.08 mins./day *v*. $FathExer_{overweight}$ = 8.25) and but there is very little difference in exercise for the mothers between the two groups ($MothExer_{healthy}$ = 11.00 mins./day *v*. $MothExer_{overweight}$ = 8.25). There is more work-to-home spillover for the mothers in the overweight group than in the healthy weight group but not much difference for fathers ($MothSpill_{healthy}$ = 1.53 *v*. $MothSpill_{overweight}$ = 1.59 and $FathSpill_{healthy}$ = 1.79 *v*. $FathSpill_{overweight}$ = 1.78). The healthy weight group consists of 82% whites and the overweight group consists of 90% whites. The mothers' and fathers' body mass index are on average higher in the overweight group ($MothBMI_{overweight}$ = 27.80, $FathBMI_{overweight}$ = 29.76) than in the healthy weight group ($MothBMI_{healthy}$ = 24.85, $FathBMI_{healthy}$ = 26.40).

The general pattern with respect to time in comparison with the 9–11 age group is that the mothers of the children in the 13–15 age group spend less engaged and disengaged time with both the healthy weight and overweight children compared to those mothers with the 9–11 group. Alternatively, while fathers of the children in the 13–15 age group spend less engaged time with the healthy weight children relative to the fathers of the 9–11 age group, fathers of the children in the 13–15 age group spend more engaged time with the overweight weight children relative to the fathers of the 9–11. Furthermore, fathers of the children in the 13–15 age group spend more disengaged time with the healthy and overweight children relative to the fathers of the 9–11 age group. As indicated above, one should not try to draw any strong inferences from just comparing means between samples, but the comparison does highlight that the patterns are very different between the 9–11 age group and 13–15 age group.

Table 7 gives the simple bivariate correlations between the child's BMI and the continuous covariates. In contrast to the 9–11 age group, almost half of the correlations do not accord in sign with an exogenous ceteris paribus intuition (*MothET*, *FathET*, *FoodExp*, *FoodBuy*, *FoodSpend*, *ParentEd*, *FathSpill*, and *White*) and only 4 are statistically significant (*FathET*, *SibNum*, *MothBMI*, and *FathBMI*). While the means and correlations appear to be very different between the 9-11 age group and the 13-15 age group, this does not imply the probit results will necessarily be qualitatively different, thus we turn to the probit analysis.

Probit Results

As in with the 9–11 age group, we first checked for endogeneity of the parents' time with the child (*MothET, FathET, MothDT, FathDT*), exercise time (*MothExer, FathExer*) and monthly food expenditures (*FoodExp*) in the 13–15 age group. The same variables were used as instruments (of course they had different values) and the same testing procedure was used as in the 9–11 age group. The test for exogeneity had a *p*-value of .19 so we proceeded with ordinary probit estimation.

Table 8 gives the probit results with the marginal effects for each variable and its corresponding *p*-value. As before, standard errors are robust and based on the cluster properties of the data. The pseudo R^2 of .48 is again relatively high for cross-sectional data. Of the 17 variables, 9 are significant at the .10 significance level (*MothDT*, *FathExer*, *FoodExp*, *ParentEd*, *SibNum*, *FoodBuy, FathSpill*, *MothBMI*, and *FathBMI*).[1] Most importantly note that of the 4 parental time variables, only mothers' disengaged time (*MothDT*) is statistically significant. Discussion is limited to those variables that are statistically significant.

In contrast to the 9–11 age group where only mothers' disengaged time was the only insignificant parental time variable, in the 13-15 age group mothers' disengaged time is the only significant parental time variable. For every additional hour a mother spends in disengaged time with the child, the probability that the child is overweight decreases by .11 (–.11 = –.0018×60), *ceteris paribus*. The other significant variables in the model with positive marginal effects are the parents' education (*ParentEd* = .06), sibling number (*SibNum* = .26), fathers' work-home spillover (*FathSpill* = .09), the mothers' BMI (*MothBMI* = .02), and the fathers' BMI (*FathBMI* = .06). All these signs are as expected, with the exception of parents' education. The food expenditure variable and grocery buy are both statistically significant but have unexpected negative marginal effects (i.e., *FoodExp* = –.0007, *FodBuy* = –.15).

Table 9 gives the matrix of marginal effects and the differences in marginal effects for the time variables of the parents. Again, statistical significance is indicated by asterisks, the diagonal elements repeat the marginal effects, and the off diagonal elements are the difference between the marginal effects labeled by the column and the row. Given the marginal effects, not too surprisingly, table 9 indicates that the only significantly different marginal effects are those involving mothers' disengaged time (*MothDT*). Given the mothers' disengaged marginal effect is –.002 and an order of magnitude greater than the

[1] Puberty is dropped from the estimation due to collinearity.

other effects, then all of these significant differences are basically of the same magnitude .002. Thus for this sample, just the presence of a mother via disengage time makes a statistically significant difference.

Counterfactual Predicted Probabilities

In the spirit of analysis done by Todd and Wolpin (2006), we address two counterfactual questions using the estimated model. First, what would happen to the predicted probability that a child would be overweight if the parental time inputs of the parents where switched between the normal and overweight groups? Second, what would happen to the predicted probability that a child would be overweight if either the mother or the father did not spend any time with the child? Tables 10 and 11 provide results of this analysis.

Table 10 shows the predicted probabilities of switching the parental inputs between the two groups, holding all other variables constant. The diagonal of the matrix is just the predicted probability for the given group with its corresponding parental time input. The off-diagonal elements are the predicted probabilities when the time inputs are switched. If the parents of overweight children adopt the average parental time allocation patterns of the parents of normal weight children (spending more time with their children), the predicted probability of the child being overweight will decrease by 14.59% for the 9-11 age group and will decrease by 10.71% for the 13-15 age group. However if the parents of normal weight children adopt the parental time allocation patterns of the parents of overweight children (spending less time with their children), the predicted probability of the child being overweight increases by 141.94% for the 9-11 age group and by 72.73% for the 13-15 age group.

Table 11 shows the predicted probabilities when one of the parents spends no time with the child or is “uninvolved” (i.e., engaged and disengaged times are set to zero). For the 9-11 age group and compared to original predicted probability of 0.031 (Table 10), if the mother is uninvolved the child’s predicted overweight probabilities increase from the original levels by 287.10% for normal weight children and 10.32% for overweight children, ceteris paribus. If the father is uninvolved the child’s predicted overweight probabilities increase from the original levels by 474.19% for normal weight children and 11.86% for overweight children, ceteris paribus. For the 13-15 age group, compared to original predicted probability of 0.022 (Table 10), if the mother is uninvolved the child’s predicted overweight probabilities increase from the original levels by 90.91% for normal weight children and 4.23% for overweight children, ceteris paribus. If the father is uninvolved the child’s predicted overweight probabilities decreases from the original levels by 13.64% for normal weight children and 5.95% for overweight children, ceteris paribus. It should be recalled that none of the father’s time variables were significant in the 13-15 age model, so this last result could be due to imprecision in the parameter estimates.

Conclusions

Using a unique dataset, this study has investigated the impact of engaged and disengaged time of both mothers and fathers on the probability a child will be overweight for two age groups of children: 9-11 and 13-15. The results are very different for the two groups.

For the 9-11 age group we find mothers’ engaged time with the child and fathers’ engaged and disengaged time with the child are all important in terms of reducing the probability that the child is overweight. However, the mothers’ marginal effect of engaged time does not appear to be significantly different from the marginal effect of disengaged time. Considering engaged time as a measure of 'quality' time with the child, the fathers' 'quality' time marginal effect on the child's overweight probability is different from his disengaged time but disengaged time has a larger marginal effect. Thus, the quality of time seems relatively unimportant and just the presence of a father play an important role for the 9-11 age group.

For the 13-15 age group we find that only mothers' disengaged time with the child is important in terms of reducing the probability that the child is overweight. Consequently, one could conceptually substitute other types of time with the child but with no real affect on the probability of the child being overweight. Thus, for the 13-15 age group, the 'quality' of time as measured by engaged time again seems relatively unimportant but mothers play an important role.

The counterfactual analysis reveals that changing the increasing the parental input levels can greatly improve the predicted probabilities that a child will be overweight. In addition this analysis also reveals that in general the child's probability of being overweight will suffer if *either* of the parents is not involved with the child, but again fathers appear to be especially important.

As with all research there are caveats. Probably the major concern is the relatively small sample size and concerns that these results are not representative. This is certainly a valid observation, but while larger sample sizes certainly exist, they also are missing several important covariates (e.g., a father's time with the child) and so the advantages of a larger sample size must be weighed against the disadvantage of a smaller number of covariates. It is not clear that a larger sample size with missing covariates is more reliable than a smaller sample with no missing covariates as presented here. With this in mind, the results here should be considered suggestive that the relationship between parental time and childhood obesity is likely to differ by parent, by type of time, and the age of the child.

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Figure 1. Example Time Diary Page

AM/PM Time Begins	AM/PM Time Ended	Main Activity	What else were you doing?	Where were you?	Who helped you do these things?
PM 6:50	*6:55 PM*	Fed the cat	N/A	Kitchen	
PM 6:55	*7:15 PM*	Gave Beth a bath and dressed her for bed	N/A ↓	Bedroom/Bathroom ↓	Husband
PM 7:00					
PM 7:10	*7:25 PM*	Read to Beth	N/A	Bedroom	N/A
PM 7:25	*7:30 PM*	Tucked in Beth	N/A	Bedroom	
		↓	↓	↓	
PM 7:30	*7:50 PM*	Showered and dressed for bed	N/A ↓	Bathroom ↓	N/A
			↓	↓	
		↓			
PM 7:50	*8:20 PM*	Watched TV in Bed	Talked to Husband	Bedroom	N/A
PM 8:00		↓	↓	↓	
PM 8:20	*5:45 AM*	Slept	N/A	Bedroom	N/A
		↓	↓	↓	
		↓	↓	↓	

Table 1. Variable Names and Definitions

Dependent Variable	Description	Units
BMI	Child's Body Mass Index	Weight kg./(Height mt.)^2
Overweight	Indicator of at risk of overweight	1 = above 85th BMI percentile; 0 = between 5th and 85th BMI percentile
Explanatory Variables		
Economic Environmental Variables		
MothET	Mother's engaged time with child	Minutes/day
FathET	Father's engaged time with child	Minutes/day
MothDT	Mother's disengaged time with child	Minutes/day
FathDT	Father's disengaged time with child	Minutes/day
FoodExp	Food expenditures	Dollars
FoodBuy	Father relative to mother power in food buying (yes/no) decision	Ordinal scale
FoodSpend	Father relative to mother power in food spending decision	Ordinal scale
ParentsEd	Parents total education	Grades completed
Social Environmental Variables		
MothExer	Mother's time in exercise without child	Minutes/day
FathExer	Father's time in exercise without child	Minutes/day
MothSpill	Mother's spillover of work to home	Ordinal scale
FathSpill	Father's spillover of work to home	Ordinal scale
SibNum	Number of siblings in home	Number
Biological/Genetic Variables		
Puberty	Measure of sexual maturity	Tanner score
Gender	Gender dummy	1 = Male; 0 = female
White	Race dummy	1 = white; 0 = other
MothBMI	Mother's body mass index	Weight kg./(Height mt.)^2
FathBMI	Father's body mass index	Weight kg./(Height mt.)^2

Figure 2. Time Variable Flow Chart

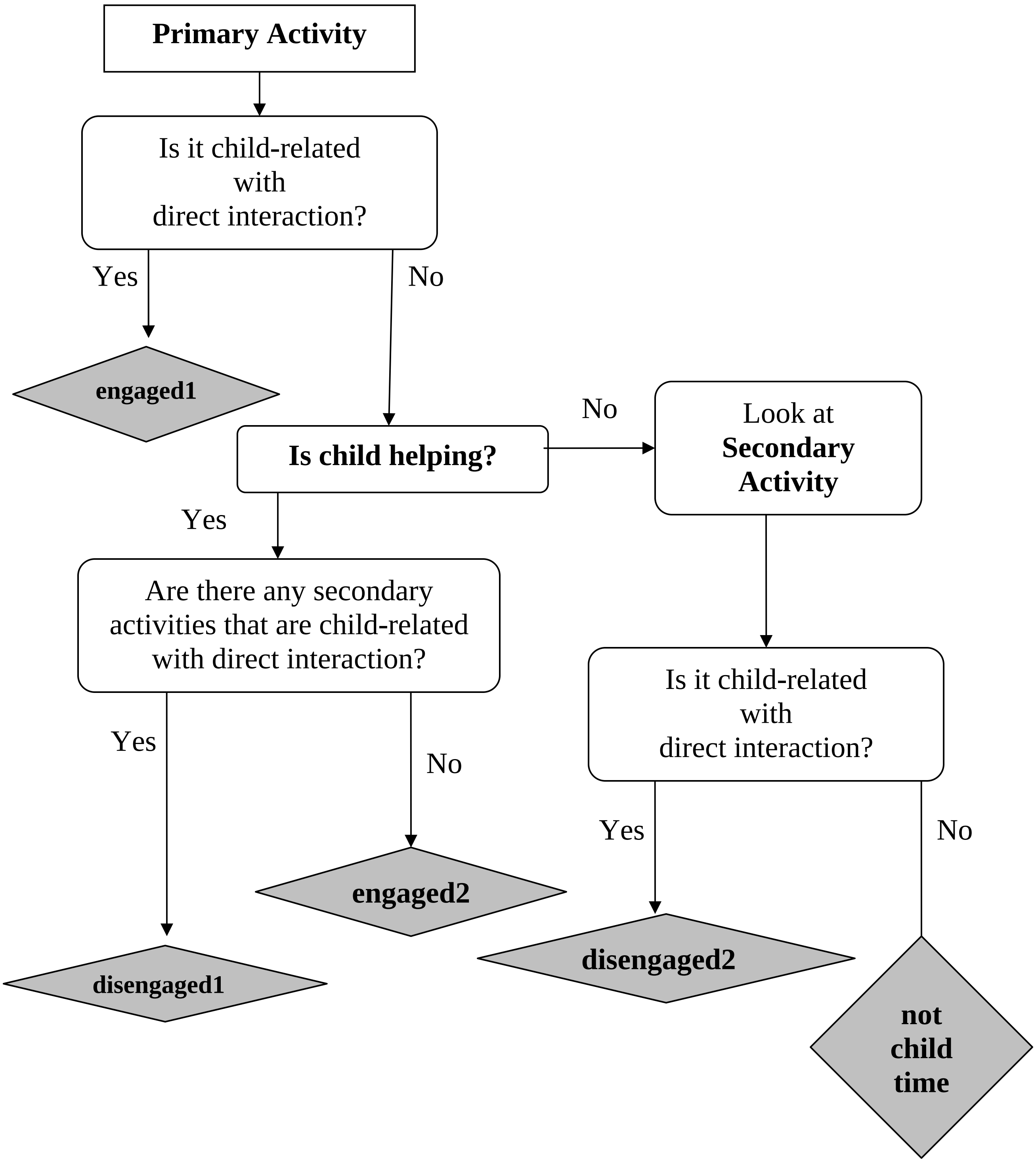

Table 2. Summary Statistics for 9–11 Age Group (N =114)

Variable	Healthy Weight (62%)	Overweight (38%)
BMI	16.55	23.03
MothET	263.56	225.39
FathET	201.32	107.91
MothDT	49.27	52.67
FathDT	30.86	21.88
FoodExp	654.71	709.95
FoodBuy	0.11	0.27
FoodSpend	0.14	0.32
ParentsEd	12.06	11.41
SibNum	1.00	1.18
MothExer	11.31	13.63
FathExer	33.7	26.73
MothSpill	1.87	2.39
FathSpill	1.85	2.09
Gender	0.40	0.45
Puberty	0.69	0.86
White	0.80	0.64
MothBMI	23.48	26.80
FathBMI	26.40	28.53

Table 3. Correlations between BMI and Covariates 9–11 Age Group

Variable	Correlation
MothET	-0.08
FathET	-0.19*
MothDT	-0.03
FathDT	-0.07
FoodExp	-0.08
FoodBuy	0.02
FoodSpend	0.11
ParentsEd	-0.26*
SibNum	0.25*
MothExer	0.02
FathExer	-0.11
MothSpill	0.23*
FathSpill	-0.03
MothBMI	0.46*
FathBMI	0.20*

* Significant at .05 level.

Table 4. Probit Results for 9–11 Age Group

	Marginal Effect[a]	P–value	95% Conf.Int.	
MothET	-0.0005	0.05	-0.001	0.0000
FathET	-0.0008	0.02	-0.002	-0.0001
MothDT	-0.0006	0.46	-0.002	0.0010
FathDT	-0.0038	0.00	-0.006	-0.0017
FoodExp	0.0003	0.30	0.000	0.0007
FoodBuy	0.3758	0.00	0.121	0.6301
FoodSpend	-0.2424	0.01	-0.439	-0.0455
ParentsEd	0.0339	0.32	-0.034	0.1019
SibNum	-0.0146	0.87	-0.185	0.1561
MothExer	0.0026	0.01	0.001	0.0045
FathExer	-0.0019	0.00	-0.003	-0.0006
MothSpill	0.5562	0.00	0.323	0.7895
FathSpill	-0.0237	0.78	-0.188	0.1409
Puberty	0.2331	0.09	0.007	0.4593
Gender	0.4716	0.01	0.124	0.8195
White	-0.1146	0.50	-0.469	0.2395
MomBMI	0.0561	0.00	0.021	0.0910
FathBMI	0.0657	0.00	0.021	0.1104
Psuedo R2	0.51			
Exog. P-value	0.39			

a. Marginal effects evaluated at sample means.

Table 5. Marginal Effects and Differences in Marginal Effects. 9–11 Age Group[a]

	MothET	**FathET**	**MothDT**	**FathDT**
MothET	-0.0005*			
FathET	0.0003	-0.0008**		
MothDT	0.0001	-0.0002	-0.0006	
FathDT	0.003**	0.003**	0.003**	-0.004**

a. Marginal effects evaluated at sample means. * Significant at .05 level.
** Significant at .01 level.

Table 6. Summary Statistics for 13–15 Age Group (N =130)

	Healthy Weight (69%)	Overweight (31%)
BMI	19.74	27.69
MothET	170.66	224.79
FathET	109.98	186.11
MothDT	47.75	32.88
FathDT	34.66	38.85
FoodExp	730.79	691.38
FoodBuy	0.36	0.00
FoodSpend	0.33	0.20
ParentsEd	12.04	12.00
SibNum	0.82	1.25
MothExer	11.00	8.25
FathExer	28.08	8.25
MothSpill	1.53	1.59
FathSpill	1.79	1.78
Gender	0.46	0.60
White	0.82	0.90
MothBMI	24.85	27.80
FathBMI	26.40	29.76

Table 7. Correlations between BMI and Key Covariates (13–15 Age Group)

Variable	Correlation
MothET	0.13
FathET	0.25*
MothDT	-0.07
FathDT	-0.11
FoodExp	-0.06
FoodBuy	-0.13
FoodSpend	-0.03
ParentsEd	0.10
SibNum	0.22*
MothExer	-0.01
FathExer	-0.10
MothSpill	0.08
FathSpill	-0.05
MothBMI	0.15**
FathBMI	0.27*

* Significant at .05 level; ** Significant at .10 level.

Table 8. Probit Results 13–15 Age Group.

	Marginal Effect[a]	P–value	95% Conf. Int.	
MothET	0.0002	0.34	-0.0002	0.0005
FathET	0.0002	0.35	-0.0002	0.0005
MothDT	-0.0018	0.00	-0.0031	-0.0005
FathDT	-0.0001	0.87	-0.0012	0.0010
FoodExp	-0.0007	0.05	-0.0012	-0.0002
FoodBuy	-0.1466	0.07	-0.2781	-0.0150
FoodSpend	0.1108	0.32	-0.0797	0.3013
ParentsEd	0.0617	0.01	0.0210	0.1025
SibNum	0.2619	0.01	0.1233	0.4006
MothExer	-0.0019	0.21	-0.0054	0.0015
FathExer	-0.0021	0.07	-0.0037	-0.0005
MothSpill	-0.0830	0.19	-0.2174	0.0513
FathSpill	0.0896	0.10	-0.0266	0.2058
Gender	0.0954	0.25	-0.0974	0.2882
White	0.0712	0.55	-0.1418	0.2841
MothBMI	0.0176	0.00	0.0028	0.0324
FathBMI	0.0604	0.00	0.0267	0.0942
Psuedo R2	0.48			
Exog. P–value	0.19			

a. Marginal effects evaluated at sample means.

Table 9. Marginal Effects and Differences in Marginal Effects. 13–15 Age Group.[a]

	MothET	FathET	MothDT	FathDT
MothET	0.0002			
FathET	0.0000	0.0002		
MothDT	0.0020**	0.0020**	-0.0020**	
FathDT	0.0003	0.0003	-0.0020**	-0.0001

a. Marginal effects evaluated at sample means.** Significant at .01 level.

Table 10. Counterfactual Results: Predicted probability of the child being overweight with different average time inputs

9-11 Age Group		Average Parental Time Input Amount		
		Normal Weight Group	**Overweight Group**	**%Change**
Other Average Inputs Amounts	**Normal Weight Group**	0.031	0.075	141.94%
	Overweight Group	0.720	0.843	-14.59%
13-15 Age Group				
Other Average Inputs Amounts	**Normal Weight Group**	0.022	0.038	72.73%
	Overweight Group	0.675	0.756	-10.71%

Table 11. Counterfactual Results: Predicted probability of the child being overweight with one "uninvolved" parent [a]

9-11 Age Group		
	Uninvolved Father	**Uninvolved Mother**
Normal Weight Group	0.178 (474.19%)[b]	0.120 (287.10%)
Overweight Group	0.943 (11.86%)	0.930 (10.32%)
13-15 Age Group		
Normal Weight Group	0.019 (-13.64%)	0.042 (90.91%)
Overweight Group	0.711 (-5.95%)	0.788 (4.23%)

a. "Uninvolved" is defined as: the parent does not spend any time with the child; in other words, the parent's time with the child (including engaged time and disengaged time) are set to zero while other variables are set at their average level for the subsample.
b. The numbers in parentheses are percentage change compared to the probability of a child being overweight setting all inputs, except specific parent time, at their mean (they are the numbers shown in the diagonal of Table 10).

Appendix

This appendix provides an overview of the child's component of a two-stage game structure along the lines of Burton, Phipps and Curtis (2002) that can be used to generate the BMI equation (4) in the text.

Obesity is the result of an energy imbalance between energy consumed (food intake) and energy expended (exercise) (Hoffman and Sawaya 1999). For children, energy consumed and expended are limited choice variables because they are influenced to a large extent by the environment created by their parents as documented in the paper. These notions suggest that a natural conceptual framework is a two-stage game between the parents and the child. The parents are taken to be the leaders and the child the follower, so the child will take the environmental variables determined by the parents as given. Given the focus of the paper, we do not present the details of the parent's optimization problem but rather take the environmental variables determined by the parents as given.

There are three components of the child's decision problem: (i) a utility function, (ii) a biological production function for their body mass index, and (iii) a time constraint. Environmental variables enter the utility function and the production function.

The child's utility depends on his/her body mass index B, the amount of food consumed x_f, the time spent in exercise t_e, the time spent in other activities t_o, and is conditional on a vector of environmental variables $\boldsymbol{E}_u$ or

$$(A.1)\quad u(B, x_f, t_e, t_o; \boldsymbol{E}_u)\,.$$

The amount of food x_f and exercise time t_e have direct effects (e.g., utility/disutility from consuming food/exercising) and indirect effects through their effects on B.

The environmental vector $\boldsymbol{E}_u$ consists of the parental resources contributed. Given the focus of this study, T_E^i and T_D^i denote engaged time and disengaged time with the child, respectively, for parent i= **M**other, **F**ather, and $\boldsymbol{X}$ denotes a vector of other inputs determined by the parents that would include total amount of food available.

The environmental vector $\boldsymbol{E}_u$ also consists of a vector of bargaining power variables between the parents $\boldsymbol{P}$ and a vector of social psychological influences $\boldsymbol{S}$ as indicated by the literature cited in the text. With these components, the child's utility function can therefore be written as

$$(A.2) \quad u(B, x_f, t_e, t_o; T_E^M, T_E^F, T_D^M, T_D^F, \boldsymbol{X}, \boldsymbol{P}, \boldsymbol{S}).$$

On the production side, a child's BMI depends directly on the amount of food consumed x_f (energy intake) and the amount of energy expended, mainly from time in physical activity t_e. However, as indicated by the literature cited in the text the efficiency with which food consumption and exercise are converted to weight is affected by biological and environmental factors, such as age, gender, puberty status, genetic factors, and stress. Let these factors be denoted by $\boldsymbol{\mu}$, so the BMI production function can be written as

$$(A.3) \quad B = B(x_f, t_e; \boldsymbol{\mu}).$$

The child's optimization problem is then to maximize utility (A.2) subject to the production function (A.3) and a time constraint $t_e + t_o = T$. Substituting the solutions into the production function (A.3) yields the solution for BMI

$$(A.4) \quad B = B(T_E^M, T_E^F, T_D^M, T_D^F, \boldsymbol{X}, \boldsymbol{P}, \boldsymbol{S}, \boldsymbol{\mu}),$$

which is equation (4) in the text.

Endnotes

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[1] The major concern in estimating production functions is that the inputs may be endogenous. In the empirical section, we will test if these variables can be considered exogenous and proceed accordingly.

[2] Depending on the game structure employed between the mother and father, the determinants of bargaining power fall under several names, such as "extra-environmental parameters" (EEP McElroy 1990) or "distributional factors" (Browning, et al. 1994) or variables representing "spheres of responsibility" (Lundberg and Pollak 1993). The formal incorporation of power with economic models of the household is a relatively new phenomenon (see Pollak 1994, 2005; Lundberg and Pollak 1996) but it has a rather long history in the more general social science literature (e.g., Blood and Wolfe 1965; Charles and Kerr 1988; Cromwell and Olson 1975). Consequently, the main determinant of bargaining power in economics has been some measure of income. While a mother's income is one measure of her power within the family, it is a measure that may not be activity specific. There are other measures of power that can be used in addition to income, such as decision outcomes indicating power (Cromwell and Olson 1975).

[3] For example, the National Health and Examination Survey (e.g., NHANES) does not have corresponding detailed data on time allocations and many other environmental variables identified here. Alternatively, national time allocation datasets, such as the American Time Use Survey do not collect child health outcomes, and only collect information on time allocation from one person in the household and again do not contain many other environmental variables identified here.

[4] Tanner drawings are commonly used in determining sexual development and consists a series of drawings of children at various stages of puberty. The child was asked to identify the picture that most closely matched his/her development. The female drawings show different degrees of breast development and pubic hair growth. In order to reduce embarrassment for the participating children, they were given an envelope containing the sex-appropriate Tanner drawings and were asked to go to another room in order to circle the appropriate level of development represented by the various choices offered. Once they had completed this task, they returned the envelope (with the drawings placed inside) to the interviewer.

[5] The age-gender adjustments are based on the 2000 CDC growth charts using a program provided by the CDC (http://www.cdc.gov/nccdphp/dnpa/growthcharts/sas.htm). The CDC does not use the term "obese" to categorize children with weight problems. Instead, a child is classified as being "at risk of overweight" if their age-gender adjusted BMI is between the 85th and 95th percentile. The child is classified as "overweight" if their age-gender adjusted BMI is greater than the 95th percentile. We only have two children below the 5th percentile, which is the underweight category, so we dropped those two observations.

[6] Correlation is a linear relationship so technically it is not appropriate between discrete variables and continuous variables. Consequently, *BMI* is used in the correlation analysis only with the continuous variables. The probit analysis to follow of course addresses this issue.