Parental Time and Children's Obesity Measures

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May 2005

Selected Paper prepared for presentation at the
American Agricultural Economics Association Annual Meetings in
Providence, Rhode Island, USA
July 24-27, 2005

Short Abstract

We develop a theoretical model that includes household production and parental time allocation to explore the effects of parental time allocation on children's obesity-related measures. We utilize a unique primary household survey dataset that has health measures and time diary records on each parent and a child in the household.

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Introduction

Childhood obesity is becoming a major concern in the United States. From 1976-1980 to 1999-2000, the percentage of obese adolescents (ages 12 to 19) increased from 7% to 15.5% and the percentage of obese children (ages 6 to 11) increased from 5% to 15.3% (American Obesity Association 2004). This increased prevalence of childhood obesity is a major concern because obese children will likely become obese adults and many adult health problems are associated with obesity, such as diabetes and heart problems. The factors affecting childhood obesity are many and not well understood. This research focuses on the effect parental time allocated to children has on childhood obesity.

In the standard nutrition literature, obesity is a function of the balance between energy intake and energy expenditure (Sadler et.al., Chapter "Energy"). Energy intake and expenditure are influenced by genetic factors and environmental factors. One environmental factor that would seem to be important is parental time allocated to the child. Adult time allocation has changed greatly over the last three decades as more women have entered the labor force. Less time at home and more time at work results in less time available for food preparation and active leisure (Chou et. al.). Meanwhile, technological changes have occurred in the food sector: decreasing time price of food consumption is leading to increased quantity and variety of food consumed (Cutler et. al.). One would expect that parental decision-making on time allocation could play a significant role in children's physical health production: declined activity time with children and increased convenient food consumption will likely negatively impact children's diet pattern and lifestyle, ceteris paribus. Unfortunately, the effect of parental time allocation on children's physical health production is an unexplored area of research.

The economic framework for analyzing the issue of time allocation and household production, such as nutrient intake and child outcomes, for many years was based on the unitary household production model. However, over the last decade major limitations of this model have been recognized and the literature has moved to collective models (Vermeulen). The collective approach and its refinements have mainly focused on modeling household labor supply decision-making (e.g., Chiappori) and the main empirical focus has been on testing the income-pooling hypothesis (e.g., Bourguignon et al.), which states that the source of income in the household is irrelevant for consumption decisions. Most work has modeled the behavior of those households without children. Some refinements have included children in the model (e.g., Bourguignon) by treating children as public consumption goods for adult household members. In terms of child related issues, some researches have considered the costs of children by treating children as individual household members (e.g., Apps and Rees). Some have explored the impact of fertility or children's health on parent's labor supply decision-making (e.g., Gould; Xie). Recently, several researches have investigated the effect of parental time allocation on children's overall quality/performance by treating children and parents as separate agents (e.g., Amuwo et. al.; Burton et. al.).

No known studies, however, have examined the effects of parental time allocation on children's physical health. Conceptually, the literature on the relationship between parents and children has not generally incorporated children's own choices into the optimization framework and has worked within a single-headed household model. This is not a very appealing approach for considering children's energy intake and expenditure since a child has some control over their energy intake and expenditure. Furthermore, a single-headed household model, much like the income pooling hypothesis, implicitly treats all time allocated to the child as the same regardless of the parent. Consequently, the potential difference of the time allocation effects between mother and father cannot be assessed.

Perhaps the main reason for these conceptual limitations has been the lack of data rich enough to consider more sophisticated models. That is, it has been difficult to investigate the relationship between parental time allocation (including market work, housework, time spent with child and own leisure) and children's physical health outcome because the desirable data set should not only include children's health status and nutrient intake but also have detailed parental time diary records on individual levels. As Haveman and Wolfe pointed out, many existing data sets cannot meet this degree of richness.

Theoretical Basis for Empirical Model

We assume that the household consists of two parents and one child and each has his own utility function. We assume that the household resource allocation is the result of a two-stage game between parents and the child. In this two-stage game setting (under the assumption of perfect information), parents are the first movers who have considered all the consequences that come with their decisions. So from the parents' perspective, the child's set of choices is known. The parents have the first mover advantage: they are able to choose their behavior choices that will lead the child to behave in the way they prefer.

Parents achieve a Pareto-efficient decision-making between them while taking into consideration the child's reaction.

We define the child's utility function as: $u(H, t_f, t_E, t_o; T_C^F, T_C^M, \theta)$, which is quasi-concave and twice differentiable. The H is the child's physical health outcome (e.g., Body Mass Index (BMI), waist circumference); t_f is the child's time spent on eating; t_E is the child's time spent on exercising and t_o is the child's other residual time. The T_C^i is parent's time spent with child, where $i = F$ (father), M (mother); θ is a vector of household environmental variables that capture the influence of the parents' work-home strain effects. The child's physical health outcome is determined by the production function $H = H(N, t_E; \mu, k^F, k^M)$, where N is the child's nutrient intake (e.g., calorie intake), μ is the child's type (e.g., race, gender, ethnicity) and k^i is parent's type (e.g., BMI, education level). Furthermore, nutrient intake is determined by the production function $N = N(t_f, t_E, X_f^F, X_f^M; \mu, k^F, k^M)$, where X_f^i is the child's food input chosen by parent. The child will choose its own time allocation variables t_i ($i = f, E, o$) to maximize its own utility function subject to the two production functions (1) and (2) and the child's time constraint: $t_f + t_E + t_o = T$ where T is the total time in a day (24 hours).

For the parents, we define individual utility functions as: $v^i(X_o^i, T_C^i, T_o^i, u; H, \theta)$, $i = F, M$, which is quasi-concave and twice differentiable. The X_o^i is parent's other goods individual consumption; T_o^i is parent's other residual time (total time minus the time spent on work and the time spent with the child). In this model, we assume that the parental time allocated to market work is fixed in the short-run, which is reasonable in cross-sectional data analysis (Amuwo et. al.). The parents will make their resource allocation decisions based on the sharing rule $W(Y^F, Y^M, \phi)$, which depicts the father and mother's bargaining power in this household and is a function of distribution factors: parent's individual total income (Y^i) and extrahousehold environmental parameter (ϕ) (which can be gender specific policies that control resources outside the family) (McElroy, 1990). Parents will choose their time allocation, the other good consumption and the food choice for the child to maximize the weighted average utility functions subject to the child's health and nutrient production functions, the budget constraint $\sum_i (X_o^i + X_f^i) = \sum_i Y^i \quad (i = F, M)$ [1] and the two individual time constraints: $T_C^i + T_o^i = T^i$, where T^i is the total time minus market working time.

Using backward induction in a two-stage game structure, the follower (child) will choose (t_f, t_E) to maximize its own utility function taking parents' decisions as given: $u\{H[N(t_f, t_E, X_f^F, X_f^M; \mu, k^F, k^M), t_E; \mu, k^F, k^M], t_f, t_E, (T - t_f - t_E); T_C^F, T_C^M, \theta\}$. The solution to this problem yields the optimal choice variable (t_f^*, t_E^*) as functions of $(X_f^F, X_f^M, T_C^F, T_C^M, \theta, \mu, k^F, k^M)$. Putting these optimal solutions back into the health outcome production function, we get the following function:

(1) $H = H(X_f^F, X_f^M, T_C^F, T_C^M, \theta, \mu, k^F, k^M)$.

In the first stage of the game, the parents will choose their decision variables taking into account the decision consequences on the child. The optimal solutions $(X_f^{F^*}, X_f^{M^*}, X_o^{F^*}, T_C^{F^*}, T_C^{M^*})$ are functions of $(Y^F, Y^M, \theta, \mu, k^F, k^M, \phi)$. Given the interest of this study to estimate the impact of parental time and income on children's obesity related

[1] We normalize the prices for food and other goods to 1 here, or the Xs can be understood as expenditure amount.

measures, we focus on estimating partial reduced forms. That is, substituting the optimal values for X_f^{F*} and X_f^{M*} into (1) yields

(2) $H = H(Y^F, Y^M, T_C^F, T_C^M, \theta, \mu, k^F, k^M, \phi)$.

The empirical work focuses on estimating equations representing (2).

Data Collection and Summary Statistics

Data collection and survey instruments

As indicated in the introduction, the desirable data set should not only include children's health status and nutrient intake but also have detailed parental time diary records. Unfortunately, no existing data set has the required degree of richness to directly associate all these variables at the individual level.

The data and results presented in this paper derive from the "Parental Time, Role Strains, Coping, and Children's Diet and Nutrition" project. The data were collected between July 2001 and June 2002. The goal was to obtain data from one child between the ages of 9-11 or 13-15 and from both of that child's parents in dual-headed households or from one child (same age categories as above) and from that child's mother (single female-headed households). Studying children under the age of 9 using complex survey instruments is problematic in terms of a child providing detailed data about themselves (Crocket and Peterson). Furthermore, the nutrition literature suggests excluding 12-year olds because this is the age at which many children undergo puberty, which can greatly influence diet intake and outcome measures.

The study required a complex set of data requirements from each participating household member to obtain the desired data. Six survey instruments were used in the collection of data. These can be grouped under three general headings:

(a) Parent's telephone interview. Each parent was interviewed over the phone to gather information about their employment status, parenting style, parental control over food and expenditures, parental feeding style, parental concern about children's eating habits, parental self-reported health and health behavior and children's health and family socio-demographics.

(b) Parent's self-administered questionnaire with time diary. The questionnaire was designed was designed to obtain both sociological and economic information from each parent. With regard to the sociological aspects, we asked each parent how they dealt with the discipline of their children and with regard to the economic aspects, we asked each parent about their sources of income and the household's expenditure patterns. Also, each parent filled out a time diary to depict how they allocated their time over two consecutive days.

(c) Children's questionnaire, 24-hour dietary recall, 24-hour activity record, physical exam, 2-day diet record, 2-day activity record. Children were interviewed in their home. The interview consisted of two parts. First, the interviewer completed a questionnaire with the child which asked questions pertaining to the parenting style of their mothers and fathers, parental pressures to lose weight and exercise, personal health habits – dieting, exercising, snacking and meal skipping, and socio-demographic background. Second, the children participated in a multiple-pass 24-hour dietary recall and 24-hour activity recall and a brief physical exam in which weight, height, triceps skinfold, sub-scapular skinfold, and waist and hip circumferences were measured. The children were then instructed in the maintenance of a 2-day diet record and 2-day activity record. Last, the children were given Tanner drawings in order to obtain an indication of their pubertal status. The child was given an envelope with the Tanner drawing and instructed to go into another room, circle the drawing that most closely resembled their body type, and then return the Tanner drawing in the sealed envelope to the interviewer.

Based on differential respondent burden (based on the number of questions asked and the amount of time on average to participate in the study), we paid each participating child $25; each mother $20; each father $15. We also held a lottery at the end of the data collection period in which two participating households were selected at random to receive $250 each. The survey details can be requested from the authors.

Random digit dialing was used to generate a sample of approximately 300 households from the Houston Metropolitan Statistical Area.

Variable Definition and Summary Statistics

The data collection process described in the previous section resulted in an extensive and very rich dataset whose complete analysis is far beyond the scope of any single paper. For this paper, we focus on the variables related to equation (2).

(2) $H = H(Y^F, Y^M, T_C^F, T_C^M, \theta, \mu, k^F, k^M, \phi)$.

There are many potential measures of health outcomes (*H*). In this study we use waist circumference, and weight and height were used to construct the Body Mass Index (BMI). For the explanatory variables, the total income for each parent (father Y^F and mother Y^M) came from the self-administered income/expenditure surveys. From the time diary records, we generated a variable that represented average time per day mother (T^M) and father (T^F) each spent with the child. This measure is the total available time in a day minus the sum of all time spent on primary activities *not* spent with the child. Consequently, this represents the amount of the average amount of time per day the parent spends with the child as a primary activity. Note that this measure does *not* distinguish between time spent in energy consuming activities (e.g., eating at home or away from home) and energy expending activities (e.g., playing soccer or watching television). We will discuss the possible implications of this in the conclusions.

The work/home role strain variables (θ) are designed to reflect the degree to which parents found that their work demands spilled over onto the family, the degree to which their work was stressful, and the degree to which they were committed to their work. All of these created a certain household environment, which brings utility/disutility to parents and the child. For each working parent, these items were subjected to principal factors factor analysis[2]. For each parent, four factors resulted from these analysis: The work to family spillover (a high score means that the parent in question is more likely to experience work to family spillover); The work commitment (a high score indicates that the parent in question has *low* commitment to her/his work); The work control (a high score means the parent will be more likely to perceive that she/he exercises *little* control over her/his work); and The work flexibility[3].

The child's type variables (μ) are gender, race, ethnicity, activity level, and puberty stage were constructed from the child interview data, with the exception of child puberty.

[2] The detail results of the factor analysis can be requested from authors.
[3] Parents may be able to carve out additional time from their work days by bringing work home with them. A two-item scale called "work flexibility" was formed. Because there were only two items used in creating these scales, the items were not subjected to principal component analysis.

The puberty stage was constructed from the Tanner development stage data. If the reported Tanner development stage data was greater than one, then a dummy variable for puberty was coded as one and zero otherwise. Activity was a dummy variable coded as one if the child participated in active exercise in at least 3 to 5 days in the last 14 days and zero if not.

The parent's type variables (k^i) were constructed from the telephone interview data. Each parent's BMI is calculated and included: father's BMI and mother's BMI. We also created parent's status variables: father's less mother's age and father's less mother's education level.

Table 1 presents the definition of the variables used in our empirical model. The descriptive statistics for 9-11 year old children are exhibited in Table 2 and those for 13-15 year old children are in Table 3. For the 9-11 year olds, waist circumference averages about 655 mm with a coefficient of variation of .17; for 13-15 years olds waist circumference averages approximately 731 with a coefficient of variation at .55. There is much more variability in the waist circumference measure for the older age group. The average child BMI for the sample is about 19 with a coefficient of variation of .22. Though not shown in the Table 6, over 19 percent of the younger children in the sample have BMI's at or above the 85th percentile (but below the 95th percentile), based on Centers for Disease Control and Prevention percentile data. An additional 19 percent have BMI's at or above the 95th percentile. For the 13-15 year olds, BMI averaged 22 with a coefficient of variation .24. Thus BMI was greater for the older age group, but the amount of variation in the two samples is similar. Though not shown in Table 7, 18 percent of the 13-15 year olds had BMI's between the 85^{th} and 95^{th} percentiles; 17 percent had BMI's greater than the 95^{th} percentile.

Turning to the independent variables in the 9-11 year old sample and starting with the control variables, 51% of the 9-11 year olds (and the 13-15 year olds) are of male gender, 72% are Non-Hispanic white, and 14% are Hispanics. Similarly, 70% of the 13-15 year olds are Non-Hispanic white while 11% are Hispanic. Among the 9-11 year olds, fathers are on average 2.3 years older than mothers and average less than a category difference in education level (.13); among the 13-15 year olds, the father-mother age difference is 2.3, while fathers and mothers have essentially the same education level (.01). The average BMI for fathers in the 9-11 year old sample is about 27 with a coefficient of variation of .15, whereas the average BMI for mothers in the sample is about 26 with a coefficient of variation of .24, indicating more variability than fathers. Similarly, fathers' BMI's among the older sample averages about 28 with a coefficient of variation of .15; for mothers, BMI averages about 26 with a coefficient of variation .21, indicating more variability than fathers.

Among the younger age group, fathers' income in the sample averages $86,377 while mothers' income averages about $26,678. Not too surprisingly, the coefficient of variation for fathers' income is lower at .63, compared to mothers' at 1.09. Similarly among the older age group, fathers' income was $79,632, while mothers' income averaged about $34,231. Again there was less variability in fathers' income (coefficient of variation=.69) compared with mothers' (coefficient of variation=1.04).

The average amount of time fathers spend daily with their 9-11 year old child in direct activities – activities that directly involve the child – in the sample is about one hour and twenty minutes (80 minutes) with a coefficient of variation of .86. Fathers' spend more time with older children, an average of about one and one half hours (95 minutes) with a coefficient of variation of 1.62, indicating considerable variability. The average amount of time mothers spend daily with their 9-11 year old child doing direct activities – activities that directly involve the child – is about two hours and five minutes (125 minutes) with a coefficient of variation of .79. In the younger sample mothers spend more time with the child and that time varies less than the time fathers spend with the child. Turning to the older age group of children, mothers' spend less time with these children, an average of approximately an hour and 15 minutes (87 minutes) with a coefficient of variation of 1.10. Again the variability of time spent with children of the 13-15 year olds was lower for mothers than for fathers.

Finally as indicated earlier, the work/home role strain variables are factors from factor analyses. As a result, the units of these variables are difficult to interpret. In general, as these variables increase then this would indicate only an ordinal – as opposed to cardinal – change in the factors these variables are designed to measure.

Multivariate Statistical Modeling Approach

First, it is important to remember that one of the two dependent variables of interest is a ratio of variables: BMI. In order to understand how the explanatory variables are affecting this ratio, it is important to allow the effect of an explanatory variable on the numerator to be different from the effect of an explanatory variable on the denominator. Second, statistically the precision of a marginal effect estimate can be improved by using all possible information about the structure of the estimation problem. The structure of the estimation problem suggests that a nonlinear seemingly unrelated regression (NLSUR) system is advantageous for several reasons (e.g., increased efficiency, internal consistency). Third, as factors, the sociological variables are imprecise measurements of underlying factors that may overlap to a large extent (e.g., work stress, work spillover). Consequently, in order to conserve degrees of freedom and increase estimation precision, we use a two-stage estimation procedure. In the first stage, the Bayesian information criterion (BIC) is used to identify the most relevant sociological factors. In the second stage, the NLSUR system estimation technique is used.

There is a long and substantial literature on the potential pitfalls of the statistical analysis of variables that are ratios (e.g. Aldrich; Kronmal; Schuessler; and Yule). The general conclusion coming out of this literature appears to be that it is important to model the components of the ratio in order to avoid spurious results (Farris et. al.). Consequently, the modeling framework needs to be flexible enough so that the dependent variables that form the numerator and denominator of a ratio can respond differently to an economic, sociological, or control variable. Because BMI is a ratio of two variables, more precise marginal effect estimates can be obtained via estimating a nonlinear seemingly unrelated regression (NLSUR) system:

(7.1) $y_1 = z_1 = \beta_{11} + X_E\beta_{1E} + X_S\beta_{1S} + X_{1C}\beta_{1C} + \varepsilon_1$: Waist Circumference

(7.2) $z_2 = \beta_{21} + X_E\beta_{2E} + X_S\beta_{2S} + X_{2C}\beta_{2C} + \varepsilon_2$: Subscapular Skinfold

(7.3) $z_3 = \beta_{31} + X_E\beta_{3E} + X_S\beta_{3S} + X_{3C}\beta_{3C} + \varepsilon_3$: Tricep Skinfold

(7.4) $z_4 = \beta_{41} + X_E\beta_{4E} + X_S\beta_{4S} + X_{4C}\beta_{4C} + \varepsilon_4$: Body Weight

(7.5) $z_5 = \beta_{51} + X_E\beta_{5E} + X_S\beta_{5S} + X_{5C}\beta_{5C} + \varepsilon_5$: Height (squared)

(7.6) $y_2 = \begin{bmatrix} \dfrac{z_4}{z_5} \end{bmatrix} = \dfrac{\beta_{41} + X_E\beta_{4E} + X_S\beta_{4S} + X_{4C}\beta_{4C}}{\beta_{51} + X_E\beta_{5E} + X_S\beta_{5S} + X_{5C}\beta_{5C}} + v_1$: Body Mass Index.

The X_E represents the economic variables (income and parental time spent with child), X_S represents sociological variables (the four factors, the two power variables and two parent's BMI), X_C: child's type variable (gender, ethnicity, puberty stage, activity). The variables in the above system are all related to anthropometric measures. Including equations for subscapular skinfold (z_2) and triceps skinfold (z_3) adds additional information that will increase estimation efficiency.

We proceed with the model estimation in two stages. First, we use an information theoretic approach in choosing which variables to include in the model. Second, to improve efficiency and impose internal consistency, systems are estimated.

In the first model selection stage, we choose to use the Schwarz's Bayesian information criterion (BIC), rather than statistical tests, to winnow down the model space (Granger et. al.; Hansen). Though the BIC model selection procedure possesses several advantages, the model space must be defined. Our theoretical framework suggests that all the other variables except for the role strain variables are easier to quantify. The role strain variables provide different measures of the impact of work on child intakes and outcomes and it is not clear that all should be included in every model. Consequently, we treat the full set of income, time, power, parent's BMI, and control variables as core variables to be included in every model. We use the BIC to select which role strain variables should enter each model. In selecting which role strain variables to include in the model, we treat the four role strain variables for each parent as four variables by requiring that the role strain variables only enter as complete pairs (i.e., with corresponding father's and mother's variables).

The model specifications that have the smallest BIC in stage I are then used in stage II. In stage II, we use NLSUR and test for heteroskedasticity using White's test. As is always the case in this type of analysis, there may be concern that some of the regressors are endogenous and need to be instrumented. We do not address this issue at this point because we feel the cure may be worse than the problem. As several authors have demonstrated theoretically and empirically, when instruments are weak, the advantages of using an instrumental variables (IV) estimator are severely compromised (e.g., Bound et. al.; Buse; and Nakamura and Nakamura). Park and Davis (2001) show in cross-sectional data sets of the type used here that the assumptions underlying IV estimation are often not satisfied. If not, the IV estimates may be worse in terms of bias and especially efficiency when compared to OLS. They find that OLS outperforms the IV estimator in out-of-sample comparisons.

Estimation Results

The marginal effects for waist circumference and BMI were calculated from the system. We separated the analysis for children 9-11 years old and for children 13-15 years old. The marginal effects along with the p-values are exhibited in Tables 4 and 5. In presenting the results, we limit the discussion to the statistically significant variables at the 0.10 level, recognizing that statistical significance does not imply biological significance[4].

9-11 Years Old Results

A $10,000 increase in fathers' income is associated with a 0.2 unit increase in children's BMI; the same increase in mothers' income is associated with an 8.07 mm

[4] The system result can be requested from authors.

increase in children's waist circumference and a 0.44 unit increase in children's BMI. Children's waist circumferences increase by 53 mm and BMI increases by 1 unit for every additional 100 minutes fathers' spend with their children; an opposing effect was seen for mothers' time. For each 100 minutes additional time mothers spend with children, their children's waist circumferences decrease by 58 mm and their BMI decreased by 2 units.

Greater fathers' work flexibility tends to be positively associated with their children's BMI. Each 1 unit increase in fathers' work flexibility increases children's BMI by 0.35 units. Each 1 unit increase in fathers' work spillover is associated with a 30.08 mm increase in children's waist circumference. Both mothers' and fathers' work spillover are associated with higher children's BMI's. An increase in mothers' work spillover leads to a 1.67 unit increase in children's BMI; a 1 unit increase in fathers' work spillover leads to a 0.78 unit increase in children's BMI. One unit increases in mothers' BMI are associated with a 0.41 unit increase in their BMI's.

In summary, first there are 6 statistically significant marginal effects for mothers' and 5 for fathers, which are comparable. Second, 4 pairs of these marginal effects overlap or are common for mothers' and fathers' – that is, if the marginal effect is significant for the mothers' it is significant for the fathers' in 4 cases. Of these 4 cases, 2 have the same sign or directional impact but 2 have the opposite sign. For example, mothers' and fathers' income are both positively related to child's BMI, but fathers' time is positively related to child's BMI and waist circumference and mothers' time is negatively related to child's BMI and waist circumference. Finally, in terms of absolute magnitudes of these 4 pairs of overlapping or common marginal effects, the mothers' marginal effects on waist circumference and BMI are greater than the fathers' marginal effects on waist circumference and BMI. Consistent with what we discussed before, these results suggests that the mothers and fathers can have very different impacts on their children's outcomes.

13-15 Years Old Results

A $10,000 increase in mothers' income is associated with 17 mm less in their children's waist circumference. Mothers' work control has an effect on their children's BMI. For each 1-unit increase in mothers' control over their work, children's BMI's decrease by 1.27 units.

For every 1-year difference in fathers' and mothers' age, children's waist circumference declines by 10.95 mm. One unit increases in mothers' BMI leads to 5.21 mm increases in children's waist circumference and 0.21 unit increases in children's BMI. Similarly a 1-unit increase in fathers' BMI leads to a 0.39 unit increase in children's BMI.

In summary, first, the number of statistically significant marginal effects for mothers' and fathers' across the two dependent variables are substantially different: 4 for mothers' and 1 for fathers'. Second, the 1 marginal effect that is significant for the fathers' do overlap or is also significant for the mothers' and it has the same sign (parents' BMI marginal effect on children's BMI is positive). Finally, the 1 significant marginal effect for the fathers' has bigger magnitude than the mothers'. Again, these results suggest that the mothers and fathers can have very different impacts on their children's intakes and outcomes.

Summary and Conclusions

This paper presents a theoretical collective model that includes household production and time allocation to capture the dynamics within the household decision-making between parents and children. The model takes into account child's own behavior influence in household decision-making and the interaction between parents. The model incorporates two household production functions: one for weight specific nutrient (e.g. calorie intake); and one for child's Body Mass Index (BMI is the obesity status indicator). We recognize the child's influence by treating mother, father and child as three separate agents with interrelationship with each other. From this theoretical framework, we are able to derive a partial reduced form for child's outcome production function for our empirical estimation.

In our marginal effect analysis, for the younger age group (9-11), somewhat surprisingly, fathers' income is found to only be associated (positively) with BMI, whereas mothers' income is positively associated with BMI and positively associated with waist circumference. Fathers' time is positively associated with waist circumference and BMI. However, mothers' time is negatively related to waist circumference and BMI. These different results for fathers' and mothers' with respect to BMI are driven by the fact that fathers' time with the child is positively associated with weight and mothers' time with the child is negatively associated with weight.

Turning to the work/home role variables, we note that fathers' work flexibility has a positive effect on 9-11 year old children's BMI, suggesting that the more fathers are able to do things such as bringing home work with them, the greater the risk of overweight in their children in this age range. Fathers' and mothers' work to family spillover has a positive effect on their children's BMI in this age group; fathers' work spillover also has a positive effect on children's waist circumference. Basically, work to family spillover increases the risk of overweight in these children. Turning to the older age group (13-15), mothers' income is negatively associated with waist circumference. Only mothers' work variables are significant in the models for the older age group. Mothers with high levels of control over their work, however, have children of this age group who have lower BMI's. Finally, father's and mother's BMI all have positive effect on their children's BMI.

There are three main themes that emerge from this study. First, mothers and fathers have different impacts on their children's outcomes. Second, it is not just the *quantity* of time and income that is allocated to children that is important, it is also the environment within which those resources are delivered. Stated more simply, the *quality* of time and income is also important. Third, mothers' and fathers' impacts on their children's outcomes decline with the age of the child: there are more significant effects in the 9-11 age group than in the 13-15 age group.

Though there are three major themes that do emerge, there is no single or simple conclusion to be drawn from our results; instead there are several. Work and money do not always have the same effect on children; exchanging less money for more time with children will not necessarily improve children's outcome. Nor will increasing salaries, by themselves, decrease the risk of obesity. Work affects children's nutrition in complex ways and this is exacerbated by the fact the fathers' work experiences affect children differently than mothers work experiences. Generally, work that permits greater control over one's time and attention appears to have more favorable consequences for children, but even in families in which one parent experiences difficulty in controlling their work experience, the other working parent may be able to compensate.

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Table 1. Variable Definitions

Economic Variables X_E :

x_1 = One (intercept)

x_2 = Father's income

x_3 = Mother's income

x_4 = Father's time spent with child

x_5 = Mother's time spent with child

Sociological Variables X_S :

x_6 = Father's spillover of work to home

x_7 = Mother's spillover of work to home

x_8 = Father's commitment to work

x_9 = Mother's commitment to work

x_{10} = Father's level of control at work

x_{11} = Mother's level of control at work

x_{12} = Father's work flexibility

x_{13} = Mother's work flexibility

x_{14} = Father's less Mother's age

x_{15} = Father's less Mother's education level

x_{16} = Father's body mass index

x_{17} = Mother's body mass index

Control Variables X_C :

x_{18} = Child gender

x_{19} = Child ethnicity

x_{21}= Child's puberty stage

x_{22} = Child's activity

Table 2. Summary Statistics for Children Ages 9 to 11

Variable	N	Mean	Std. Dev.	Minimum	Maximum
<u>Dependent Variables</u>					
Waist (y_1)	169	655.60	111.67	245.00	1046.00
Body Mass Index (y_2)	169	19.48	4.32	12.95	38.48
<u>Independent Variables</u>					
Economic Regressor Matrix X_E :					
Father's Income (x_2)	116	86376.88	54432.54	8000.00	370000.00
Mother's Income (x_3)	112	26677.75	29237.81	0	160000.00
Father's Time Spent with Child (x_4)	112	80.42	68.81	0	419.00
Mother's Time Spent with Child (x_5)	148	124.64	98.63	0	539.50
Sociological Regressor Matrix X_S :					
Father's Spillover of Work to Home (x_6)	129	-.05	.89	-1.66	2.63
Mother's Spillover of Work to Home (x_7)	115	1.64E-3	.81	-1.54	2.28
Father's Commitment to Work (x_8)	129	2.95	.95	1.00	5.00
Mother's Commitment to Work (x_9)	112	2.83	.96	1.00	5.00
Father's Level of Control at Work (x_{10})	127	4.2E-3	.88	-1.19	3.73
Mother's Level of Control at Work (x_{11})	113	-.01	.94	-1.28	3.58
Father's Time Flexibility at Work (x_{12})	129	3.36	1.04	1.00	5.00
Mother's Time Flexibility at Work (x_{13})	113	3.44	1.00	1.00	5.00
Father's less Mother's age (x_{14})	132	2.30	4.49	-6.00	33.00
Father's less Mother's education level (x_{15})	132	.13	1.46	-3.00	4.00
Father's BMI (x_{16})	132	27.63	4.17	19.90	45.78
Mother's BMI (x_{17})	166	26.10	6.25	17.59	58.36
Control Regressor Matrix X_C :					
Gender (x_{18})	169	.51	.50	0	1.00
Race (x_{19})	167	.72	.45	0	1.00
Ethnicity (x_{20})	167	.14	.35	0	1.00
Child's Puberty Stage (x_{21})	153	.71	.46	0	1.00
Child's Activity (x_{22})	169	.71	.46	0	1.00

Table 3. Summary Statistics for Children Ages 13 to 15

Variable	N	Mean	Std. Dev.	Minimum	Maximum
<u>Dependent Variables</u>					
Waist (y_1)	142	731.14	131.56	260.00	1213.00
Body Mass Index (y_2)	141	22.42	5.41	14.80	45.97
<u>Independent Variables</u>					
Economic Matrix X_E :					
Father's Income (x_2)	94	79631.51	55136.59	1200	283044
Mother's Income (x_3)	106	34231.37	35431.07	540	250000
Father's Time Spent with Child (x_4)	96	94.69	152.98	0	967
Mother's Time Spent with Child (x_5)	126	87.37	96.13	0	530
Sociological Regressor Matrix X_S :					
Father's Spillover of Work to Home (x_6)	106	.07	.90	-1.85	2.79
Mother's Spillover of Work to Home (x_7)	109	.04	.82	-1.50	2.33
Father's Level of Control at Work (x_8)	103	.01	.90	-1.19	2.78
Mother's Level of Control at Work (x_9)	101	-.08	.75	-1.28	2.36
Father's Commitment to Work (x_{10})	106	2.93	.98	1	5
Mother's Commitment to Work (x_{11})	105	2.8	.93	1	5
Father's Time Flexibility at Work (x_{12})	105	3.63	.89	1	5
Mother's Time Flexibility at Work (x_{13})	105	3.40	.95	1	5
Father's less Mother's age (x_{14})	110	2.29	4.22	-8.00	18.00
Father's less Mother's education level (x_{15})	109	.01	1.44	-3.00	3.00
Father's BMI (x_{16})	111	27.55	4.02	17.63	39.13
Mother's BMI (x_{17})	140	26.04	5.55	17.97	46.02
Control Regressor Matrix X_C :					
Gender (x_{18})	142	0.51	0.50	0	1
Race (x_{19})	142	0.70	0.46	0	1
Ethnicity (x_{20})	142	0.11	0.32	0	1
Child's Puberty Stage (x_{21})	138	.99	.08	0	1
Child's Activity (x_{22})	142	0.76	0.42	0	1

Table 4. Marginal Effects on Waist Circumference and Body Mass Index (BMI): Age 9 to 11[a]

Variables	Waist Circumference	BMI
Father's income	3.0E-4 (.25)	2.0E-5 (8.0E-4)
Mother's income	8.07E-4 (.06)	4.4E-5 (<1.0E-4)
Father's Time	.53 (4.0E-3)	.01 (1.5E-3)
Mother's Time	-.58 (1.9E-3)	-.02 (2.0E-4)
Mother's Time Flex		-.20 (.23)
Father's Time Flex		.35 (.10)
Mother's Spillover	25.97 (.17)	1.67 (<1.0E-4)
Father's Spillover	30.08 (.03)	.78 (2.3E-3)
Age difference	.44 (.92)	.14 (.15)
Edu difference	-4.16 (.67)	-.14 (.54)
Mombmi	.96 (.77)	.41 (<1.0E-4)
Dadbmi	-1.13 (.79)	-.01 (.88)

[a] P-value in parenthesis.

Table 5. Marginal Effects on Waist Circumference and Body Mass Index (BMI): Age 13 to 15[a]

Variables	Waist Circumference	BMI
Father's income	-4.5E-4 (.16)	-1.0E-4 (.18)
Mother's income	-1.66E-3 (.02)	-3.0E-5 (.23)
Father's Time	.01 (.90)	-1.62E-3 (.55)
Mother's Time	.03 (.88)	.01 (.42)
Mother's Control	12.72 (.55)	1.27 (.08)
Father's Control	-6.78 (.67)	.20 (.72)
Age difference	-10.95 (.02)	-.17 (.23)
Edu difference	16.16 (.15)	.38 (.29)
Mombmi	5.21 (.05)	.21 (.02)
Dadbmi	6.74 (.11)	.39 (.01)

[a] P-value in parenthesis.