Household Food Expenditures, Parental Time Allocation, and Childhood Obesity

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Overweight and obesity are among the most pressing health challenges today. Nationally, the current annual cost of overweight and obesity is nearing $117 billion (US DHHS, 2001). Meanwhile, the sudden increase in childhood obesity in the United States is especially well documented and alarming. An estimated 14% of children between the ages of 6 and 17 are at-risk for overweight; an additional 11% are overweight (Troiano and Flegal). Many negative childhood health disorders (e.g. asthma, diabetes etc.) are associated with obesity. In addition, because of the established positive relationship between childhood obesity and adult obesity (e.g. Serdula, et al. 1993), the future adult morbidity rates are expected to increase in the future. Consequently, the already high economic cost associated with obesity is expected to increase dramatically in the future.

The factors affecting the childhood obesity are many and not well understood. In the standard nutrition literature, obesity is a function of the balance between energy intake and energy expenditure (Hoffman and Sawaya). Energy intake and expenditure are influenced by genetic factors and environmental factors. The changing family and social environment are shown to be the likely culprit in the case of childhood obesity (e.g. Chou, Grossman, and Saffer). As Lindsay et al. pointed out, parents are key to developing a home environment that fosters their children's development of lifelong habits, such as eating patterns and physical lifestyles. Household food expenditure and parental time allocation are two obviously important home environmental factors. What are the changes in those two factors recently and what are the relationships between those changes and the rising childhood obesity?

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, Grossman, and Saffer).

Meanwhile, technological changes occurred in the food sector has led to increased quantity and variety of food consumed (Cutler, Glaeser, and Shapiro). Higher frequency of family meal skipping, declined activity time with their children and increased convenience food consumption will be likely to negatively impact children's diet patterns and lifestyles, ceteris paribus.

This paper aims at exploring the influence of household food expenditures, parental time allocation and other parental factors on children's obesity-related health outcomes while focusing on examining the potential differences between the marginal effects of paternal choices and maternal choices.

Literature Summary

No known studies have examined the interrelationship between household food expenditures, parental time allocation, and children's obesity-related health outcomes. However, this research topic falls naturally into the area of "household production of health" which is being studied by a variety of disciplines: anthropology, social psychology, and economics. Each discipline has its own sets of factors and model frameworks to work on although they do overlap to a certain degree. To conduct a thorough examination on HHPH, it calls for interdisciplinary quantitative and qualitative research work (Berman, Kendall, and Bhattacharyya; Haveman and Wolfe). This study incorporates nutrition literature and sociological factors into economic analysis.

Economic Literature Summary

In economic literature, there has been an enormous amount of work done on household behavior modeling both in theoretical development and in empirical applications.

However, there is little research on examining the influence of parents on their children's health outcomes. The children's attainment literature does explore the influence of the parental choices on children's attainment. But in those studies, the attainment definitions do not include children's obesity-related health outcomes and parental time allocation choices are not considered as potential determinants. The research question we are examining covers three key areas: household health production, interaction between parents, and parents-child interaction. Because the related literature is enormous, we will only discuss those directly related.

Becker (1965) introduced the household production model (HPM) into the traditional consumer behavior analysis. It models households as consumers as well as producers. One of the household goods produced can be children's health outcomes. The theory development has gone through several waves of modifications.

In the original HPM, the household acts as a single decision-making unit even though the household consists of different individuals. The associated household model is called "unitary model". The properties of demand functions and the "income pooling hypothesis" derived from the model were repeatedly rejected in the literature (e.g. Bourguignon et al.; Lundberg, Pollak, and Wales).[1] Furthermore, the unitary model, much like the income pooling hypothesis, implicitly treats all time allocated to the children as the same regardless of the source. Consequently, the potential difference of time allocation effects between mothers and fathers cannot be assessed.

This study adapts the latter theoretical development, "non-unitary models", which treats the household members as distinct individuals with common interests as well as

[1] The "income pooling hypothesis" states that the household pools all non-labor income together to optimize the household utility, however, the source of unearned income does not affect the intra-household resource allocation.

conflicts. This paper builds on one of the approach called "collective model" which was developed by Chiappori (1988, 1992), and Apps and Rees (1988). Instead of imposing a particular bargaining rule, it assumes only that the household decision-making process will always result in Pareto efficient outcomes. This Pareto efficiency assumption has been justified as the natural result of repeated long-term games, with the household dynamic as one example (Browning and Chiappori).

Most work on collective models has modeled the behavior of households without children. Some refinements have included children in the model by treating children as public consumption goods for adult household members (e.g. Bourguignon) or as individual household members with no influence in the production process (e.g., Apps and Rees 2002; Xie). This is not a very appealing approach for considering children's physical health productions (especially obesity-related ones) in that a child can have increasing control over energy intake and expenditure as it grows older.

Modeling parents-child interaction started from Becker's "Rotten Kid Theorem". This theorem describes family members' interaction with a two-stage game and can be put into standard principal-agent theory language (Becker 1981). The similar model has been used in children's attainment literature (Cigno, Luporini and Pettini; Weinberg; Burton et al.). The two-stage game is an intuitive way to model interaction between parents and child which this paper uses.

Sociological Literature Summary

There are several factors sociology considers in the HHPH: role theory, work flexibility, work commitment, work-to-home spillover, parents' power difference, and heredity.

Role theory states that there are many socially prescribed roles that individuals take on which demand individual resource allocation. When role demands exceed the time and energy resources of an individual, there will be either conflict between different roles or within the same role where partners share the work load and create stress (Pearlin).

Work stress is an important factor affecting working parents' behavior. Negative emotional and physical consequences associated with work stress have been found in the literature (e.g. Karlsson, Knuttson and Lindahl; Rau and Triemer). Work flexibility and work commitment are two important causes. Several studies suggest that work stress can also lead to tension in spousal relationships and have a negative impact on parents-child interaction (e.g. Crouter and Bumpus; Kinnunen, Geurts, and Mauno). This describes another sociological factor in family life: some roles' conflict spills over to other roles. Work-to-home spillover is the most relevant one for working parents. Work flexibility, work commitment and work-to-home spillovers are also found to affect family eating habits (e.g. Devine et al.).

The sociological literature also shows that the power difference between husband and wife will benefit the one with the higher status (e.g., Blumberg). This suggests the potential linkage between parents' power differences and household decision-making. Heredity has also been proved to be an important factor in children's intake and outcomes. Several studies have suggested the positive relationship between parental BMI and their children's BMI (e.g., Agras et al.).

A lot of work in the field of sociology has focused on health determinants. Within this literature, some have considered children's health outcomes, but they do not specifically analyze parental time devotion effects on children's health outcomes and there is no common framework to guide the empirical variable selection.

Theoretical Model

The theoretical model considers a multi-person household with two parents and one child, each with his/her own utility function. We model the parents-child interaction as a two-stage Stackleberg game while keeping collective model structure within the father-mother interaction. By doing so, we are able to disentangle the individual parent's interaction with the child and derive the child's health production function with parental time allocation variables as arguments. So we can empirically analyze the parental influence on the child's health production outcomes in a theoretically consistent way.

Production Function

We define the child's obesity-related health production function based on nutrition literature. The metabolism of nutrients (i.e., energy) in the human body is mainly about energy balance (Hoffman and Sawaya):

(1) Energy Intake = Energy Output $\pm$ Energy Stored.

This indicates that the children's obesity-related health production function should have two main components: energy intake and energy output. Those two components are influenced by numerous factors and we define our function components accordingly. The children's obesity-related health, *H*, is determined by the following production function based on equation (1):

(2) $H = H[n(x_f, t_f, t_E, X_f^F, X_f^M, T_f^F, T_f^M; E_H, E_P, K), t_E; K]$, where *n*() is the nested energy intake production function and the other captures the factors influencing the

energy output.[2] t_E is child's time spent in exercising, K is a vector of individual type variables for the child (k), the father (K^F) and the mother (K^M).

The nutrient intake, n, is influenced by several factors. Child's food input choices made by self (x_f), child's food input choice made by father and mother respectively (X_f^F, X_f^M), and father's and mother's time spent in food preparation respectively (T_f^F, T_f^M) capture the composition of the meal; and along with child's time spent in food consumption (t_f), they capture the food availability to the child. t_f and k also capture the palatability factor. Home environment (E_H), peer influences (E_P) and child and parents' type variables capture the social and family influence while the type variables also capture psychological state of the child. The production function (equation (2)) is assumed to exhibit non-increasing returns and to be twice differentiable.

We should note that when all the energy intake and energy output related variables are fixed, the only way the obesity-related physical health outcome will change is through the person's genetics. Genetics are not influenced by the amount of parent-child time. So in our model, the parental time spent with the child only can indirectly influence the child's health outcome through optimal solutions.

Optimization Framework

Our model treats parents and the child as individuals with different preferences and own sets of choices. Each individual's utility function is strictly quasi-concave and at least twice continuously differentiable. The child's utility function is defined as:

(3) $$u(H, t_f, t_E, t_o; T_C^F, T_C^M, E_H, E_P).$$

[2] The energy output has three components: basal metabolic rate, thermogenic component and physical activity and arousal. The first two are related to age, gender, state of health and fitness, etc. The last one depends on the intensity and the duration of the activity involved (Hoffman and Sawaya).

The child divides his/her own time among food consumption (t_f), exercise (t_E) and other residual activities (t_o). The child will maximize his/her own utility, equation (3), by making his/her own decisions on the set of choices, (x_f, t_f, t_E, t_o), while facing the production function constraint (equation (2)) and the time constraint. Father's and mother's time spent with the child, (T_C^F , T_C^M), enter the child's utility function directly to capture the direct welfare the child gets from spending time with his/her parents.

We allow the parents to have their individual specific preferences. Their individual utility function is then:

(4) $$v^i[X_o^i, T_C^i, T_f^i, T_w^i, T_o^i, E_H, E_W, u(\cdot); H], \; i = F, M.$$

X_o^i is the parent's individual composite market good consumption, with the price set to unity. E_W depicts parent's work environment. Each parent will allocation his/her own time among: time spent with the child (T_C^i), food preparation (T_f^i), market work (T_w^i), and the other residual activities (T_o^i).

In the Beckerian sense, both of them are "egoistic" toward each other but exhibit the combination of "caring" and "altruistic" toward their child. This means that, among the parents, each parent's own consumption and time allocation choices have no effect on the other. However, they both care about their child's welfare, *u*, in a way that the child's welfare outcome will bring direct utility to them and they do not care how the welfare is achieved except through health outcome, *H*. Meanwhile both parents do not merely want their child to feel "happy" (achieve its maximum utility level). Instead, they want the child to have a certain level of health outcome even though this may bring the child a certain level of disutility.[3]

Following the collective model framework, we only assume that parents' decision process will lead to Pareto efficient allocation results between them. The parents will form a parents' utility function, *v*, using an implicit weight, *W* (Chiappori 1992).[4] *W* summarizes the decision process and determines the final location of the optimal solutions on the Pareto frontier. The parents' utility function, *v*, is then a weighted average of the parent's individual utility functions:

(5) $v = v^F + W \cdot v^M$.[5] The parents will make their decisions on the set of choices, $(X_f^F, X_f^M, X_o^F, X_o^M, T_C^F, T_C^M, T_f^F, T_f^M, T_w^F, T_w^M, T_o^F, T_o^M)$, while facing the child's health production function constraint (equation (2)), a household budget constraint and two individual time constraints. The budget constraint is:

(6) $\sum_i (X_o^i + X_f^i) = \sum_i (w^i T_w^i + I^i) \quad i = F, M$,[6] where w^i is individual wage rate, T_w^i is individual market work time and I^i is individual unearned income.

The Two-Stage Game

The first issue for setting up a Stackleberg game is to choose the leader and the follower. In the context of parental time allocation influence on the child's obesity-related health

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[3] For example, the child and his parents may have different perceptions about overweight and obesity. The overweight or obese child may not feel any discomfort or he may only feel the peer pressure and self-esteem struggling; the parents may concern about the child's health status and related medical burden. Then the conflict will arise due to this perception gap.

[4] Browning and Chiappori call it a "distribution of power" function and it generally depends on the "distribution factors" that affect the distribution of "power" within the household but do not affect the preferences directly, such as individual wage rates and unearned income.

[5] The *W* function here represents the ratio of the mother's power over the father's power. Its value can be greater than 1 in the case of the mother having a larger distribution power in the parents decision process.

[6] We normalize the composite commodity and the food inputs price to unity. The LHS of equation (8) can be treated as the sum of the expenditures. The equality sign is based on non-satiation assumption.

outcome, it is more realistic to assume that parents are the ones who set the family rules (act as the leader) and the child is the follower. The testing of the game structure assumption is beyond the scope of this paper and is one of the future study topics.

Now we have the following Stackleberg game structure. Stage 1: The two parents are acting as the Stackleberg leader and they maximize their collective utility function, *v*, for any given decision choice of the child. Stage 2: The child observes the parental decisions then makes his/her own choices.

We assume perfect information flow between parents and the child and within parents' interaction. It is because: First, efficient outcomes are naturally resulted from long-term interaction in multi-person households, and asymmetric information will weaken the efficiency conditions; Second, it will complicate our analysis and distract us from the purpose of this study.

Empirical Model

The two-stage game presented above leads to two specifications for the child's obesity-related health production function, *H*.

In the second stage of the game, the child makes decisions on his/her own food choice and time allocations taking the parental decisions as exogenous. The child's optimal choices are functions of the parental decisions and the other exogenous variables: $(X_f^F, X_f^M, T_f^F, T_f^M, T_C^F, T_C^M, E_H, E_P, K)$. So the optimal health production function is:

(7) $$H = H^*(N^*, t_E^*; K) = H(X_f^F, X_f^M, T_f^F, T_f^M, T_C^F, T_C^M, T_C^J, E_H, E_P, K).$$

In the first stage of the game, the parents make their decisions based on *W*, to achieve Pareto efficient resource allocation. Because they are able to act before the child, the parents can form their best responses to any given set of the child's optimal decisions.

The parents' optimal choices are functions of the exogenous variables of the model: $(w^F, w^M, I^F, I^M, E_H, E_P, E_W, K)$. This stage gives us:

(8) $$H = H^{**}(N^{**}, t_E^{**}; K) = H(w^F, w^M, I^F, I^M, E_H, E_P, E_W, K).$$

Equation (8) is the reduced form equation of the model because all its exogenous variables are predetermined in both stages of the game. However, it does not provide us with the information needed to disentangle the partial effects of the parental decisions.[7] Equation (7) preserves the relationship between parental choices and the child's obesity-related health outcome, which is the focus of our study. We use this equation to specify our empirical production function.

Rosenzweig and Schultz point out that, for the general health production problem, the health technology estimation should take into account health inputs' self-selection issues and this type of estimation must be obtained from a behavioral model that treats health inputs as choice variables, which we have done in the theoretical model. The parental stage of the game provides us with instrument choices for parental health inputs. We can estimate equation (7) using two-stage least squares (2SLS) to obtain consistent estimators. However, the 2SLS estimation, although achieving consistency, is not efficient because it ignores the reduced-form restrictions implied by the theoretical model (Court; Rosenzweig and Schultz). A potential and achievable efficiency can be gained if we put the structural equations of interest together with any number of reduced form equations and estimate all of them jointly as a system (Court; Rosenzweig and Schultz). Available data points and the degree of freedom problem are common among cross-sectional data sets, and is the case with our collected data set as well. By estimating an

[7] As Rosenzweig and Schultz point out, the reduced form health equation (e.g., equation (8)) does not provide information on underlying household health technology.

empirical system instead of a single empirical equation, we also gain the degree of freedom by increasing the number of available data points.

Before discussing the identification issue of this empirical system, we need to verify that the data needs of this empirical system match our collected household survey data set. Due to the data limitation, the parent's individual food expenditure choices, (X_f^F, X_f^M), have to be replaced with the household's food expenditure, X_f; we have to assume that the time allocated to work, (T_w^F, T_w^M), has been predetermined and remains constant in the short run (Amuwo et al.). [8] The total time available changes from 24 hours per day for all individuals to non-work time available per day for individuals, (T^F, T^M).

The modified empirical system allowing for data limitations becomes:

(9) $$H = H(X_f, T_f^F, T_f^M, T_C^F, T_C^M, E_H, E_P, K)$$

(10) $$B = B(Y^F, Y^M, E_H, E_P, E_W, K, T^F, T^M), B' = [X_f, T_f^F, T_f^M, T_C^F, T_C^M].$$

Equation (10) is a group of five reduced form health input equations with the same set of exogenous variables.[9] So this empirical system consists of six equations with five reduced form equations (equation group (10)) and one structural equation (equation (9)). The five equations in (10) are already identified by their reduced form properties. The identification issue of this empirical system rests on the identification of equation (9).

There are five exogenous variables, $(Y^F, Y^M, T^F, T^M, E_W)$, that are excluded from health production function (9) and five included endogenous variables, $(X_f, T_f^F, T_f^M, T_C^F, T_C^M)$, that are in the equation. This means that equation (9) is *exactly*

[8] This can be a reasonable assumption for cross-sectional data which covers a short period of time.
[9] They are the reduced form health input demand functions derived from parental stage of the game.

identified if all the variables are scalars.[10] The work environment variable, E_W, may include the work flexibility and the work commitment which will make equation (9) *over-identified*.

If we organize the system by putting the endogenous variables all to the left hand side of the equations, the associated left hand side coefficient matrix is a special case of an upper triangular matrix which makes it a the triangular system (Greene; Kmenta). The system is qualified as a general triangular system with non-diagonal disturbance covariance matrix, Σ, because of the possible endogeneity problem.

The general triangular system can be estimated consistently by using the seemingly unrelated regressions (SUR) method. However, the efficiency will only be gain if the covariance matrix, Σ, is known which is almost never the case in practice (Lahiri and Schmidt). Lahiri and Schmidt suggest using the iterated SUR (ITSUR) to achieve the algebraically same results as the full information maximum likelihood (FIML) estimator. However the covariance matrix from the ITSUR may not be consistent (Prucha).[11] It is well known that when the covariance matrix, Σ, is unknown, the FIML and 3SLS are equally efficient. We choose to use the iterated 3SLS (IT3SLS) as the procedure for our triangular system estimation.

As is common in cross-sectional analysis, the instruments we have may be weak which will result in poor and misleading asymptotic properties (Park and Davis). So both the ITSUR and IT3SLS results will be presented and the robustness across both estimators will be examined. Our triangular system has a well laid out theoretical framework support which minimizes the potential equation misspecification. We choose

[10] As Greene points out, in general, a model that passes the order condition will meet the rank condition.
[11] A consistent covariance matrix estimator can be obtained by using the parameter estimates from the iterated SUR as starting values for a FIML routine and taking the standard errors from the routine (Prucha).

the semi-log functional form for the production function and the linear functional form for all reduced form health input demand equations.[12]

Data and Summary Statistics

The main reason for the conceptual limitations in this line of research has been the lack of data rich enough to consider more sophisticated models. The desirable data set should not only include children's health status and nutrient intake but also have detailed food expenditure and parental time diary records on individual levels.[13]

This study utilizes a unique first-hand multi-disciplinary household survey data set. It not only covers sociological aspects of the family, financial structure information and demographic details, but also provides dietary intake details and two-consecutive-day time diary records. Also the above detailed information is available for each participating member of the household (two parents and one child). The data set was collected between July 2001 and June 2002 and the data were drawn from over 300 households in Houston (MSA), Texas. The sample was generated through random digital dialing. The survey covered children of age 9 to 11 or 13 to 15. Getting complex data from children under 9 years old is problematic and children usually undergo puberty at age 12 which can greatly influence their diet intake and outcome measures (Crocket and Peterson).

Data Specification

Table 1 reports detailed descriptions of variables used in the empirical analysis including variable names, definition descriptions, and units. We will focus on presenting the data generation process for the time variables and some key variables.

[12] The functional form selection should be considered for future study.
[13] As Haveman and Wolfe pointed out, many existing data sets cannot meet this degree of richness.

For this study, we use a continuous BMI score as the indicator for the child's obesity-related health outcome, *H*. BMI scores were calculated from the child's weight and height anthropometric measurements according to the BMI definition. Household total monthly food expenditure, X_f, is a sum of the following three spending categories: (a) money spent on groceries and other food items eaten at home; (b) money spent on take-out and food delivered eaten at home; (c) money spent on going out to eat.

There are two parental time allocation variables that enter the child's obesity-related health production function, the parental time spent in food preparation, (T_f^F, T_f^M), and the parental time spent with the child, (T_C^F, T_C^M). These time variables are averaged minutes per day generated from the two-day time diary record using primary activities as the criteria. Parental time spent in food preparation includes: the time spent in preparing meals, drinks and snacks, and the time spent in food clean-up and buying take-out food. Parental time spent with the child is a residual time amount which is derived by subtracting the total of parental time *not* spent with the child from the total available time in a day (1440 minutes).[14] The last parental time variable is the total non-working time available to each parent, (T^F, T^M). This variable is also a residual time and is equal to the total time per day (1440 minutes) minus parental time market work time per day.

Our empirical model has work environment, E_W, as an exogenous variable so our sample is a subset of the data set and covers only those households with two working parents. In our sample, the two-consecutive-day survey period varies across individual households. It is important to distinguish the time allocation pattern for workday versus

[14] It should be mentioned that this measure does not distinguish between the time spent in activities that contribute to energy intake (e.g., consuming food) and those that qualify as energy expenditure (e.g., exercising). Although this measure does capture the general quantity of parental time spent with the child, it cannot fully depict the quality of the time.

non-workday. For this study, we follow the following time variable generation rule: The generated time allocation variables should represent workday patterns when at least one workday is reported; they should capture non-workday patterns when the two days are both non-workdays.

The theoretical model presented above contains three types of environmental variables: home, peers and parent's work. They capture home and social influences. The home environment, E_H, is captured by a factor, created from the principal factors factor analysis. This factor captures work-to-family spillover and depicts the home environment caused by work-related negative impacts such as no energy, no time for family and poor father/mother role performance. A high score indicates that the parent is more likely to experience work-to-family spillover. The data set does not provide good measurement for the child's peer influence. The parent's work environment, E_W, has two main factors: work flexibility and work commitment. We use two variables to capture work flexibility for each parent: work hour flexibility and work day flexibility. The value ranges from 1 to 3 or from inflexible to highly flexible. Work commitment captures the importance parents place on their jobs relative to other roles in life. The answer ranges from 1 to 5 indicating the parent's commitment to work from very low to very high.

We use parent's BMI scores to capture heredity effects and parent's education level and active level to depict parent's types. We use two rank variables, (ToBuy, ToSpend), generated from two decision power related survey questions to capture the relative power difference between the father and the mother on two food-related decision-makings: whether to buy groceries; how much to spend on groceries. As the rank increase, the father will have relatively more decision power on the category.

Summary Statistics

The entire data set has a maximum of 325 household records and each household record has three sets of data: the father's data, the mother's data and the child's data. We report only the sample that contains households with complete information from both parents and the child for the variables of interest. The empirical analysis was conducted on the sample without splitting age groups first (pooled model), then on two sub-samples: younger group (age 9 to 11) and older group (age 13 to 15). It allows us to explore the potentially different parental impact on children as compared to adolescents.

The summary statistics for the pooled model are reported in Table 2. We will discuss key variables of interests. The sample size is 125 observations. The average total household monthly expenditure on food is about $690.64 with a huge variation: the minimum is $210.00 and the maximum is $1,579.00. The fathers' average total income is larger than the mothers' average total income and also is of less variability compared to the mothers': the coefficients of variations (CVs) are 68% and 105% respectively. On average, mothers devote more time to the family compared to fathers: Mothers spend an average of about one hour a day in food preparation (65 minutes), while fathers spend an average of 20 minutes. The average time mothers spent with their children is about one and a half hours (90 minutes) while fathers spend an average of one hour and nineteen minutes (79 minutes). It is a consistent pattern that fathers' time devotion to the family has larger variability: The CVs of the food preparation time are 122% and 83% for the father and the mother respectively; the CVs of the parental time spent with the child are 142% and 102% respectively. Meanwhile, mothers have more available non-working time per day on average compared to fathers and with less variability. In the sample, 90%

of the fathers and 80% of the mothers reported at least one workday time allocation pattern.

The children's BMI cut-off points vary according to the children's gender and age and the mean here does not have clear cut-off points to compare with. Fathers have higher average BMIs than mothers (27 vs. 25) and both means belong to the adult "overweight" category ($25 \leq BMI<30$). Mothers have more variability in BMI than fathers. In our sample, 49% are boys, 79% of the children are non-Hispanic white, 11% are Hispanic, 88% of the children are pubescent.

After splitting the sample, we have 59 observations in the younger group and 66 observations in the older group. These two groups' summary statistics are presented in Table 3 and 4 respectively. The average monthly household food expenditure is similar across the two groups with the average of $674.35 in the younger group and $705.20 in the older group and they are of same variability (about 34%).

On average, parents with older children spend relatively more time in food preparation compared to those who have younger children. The difference is larger in father's food preparation time devotion: fathers spend average 15 minutes a day in younger group and 24 minutes a day in older group. On the other hand, parents of young children spend more time with children compared to those of older children: in the younger group, fathers spend an average of one hour and twenty minutes per day (80 minutes) with their children while mothers spend around two hours per day (112 minutes); in the older group, fathers spend about one hour and eighteen minutes per day (78 minutes) on average with their children and mothers spend about one hour and twelve minutes (72 minutes). Mothers of younger children spend relatively more time with children than fathers while fathers of older children spend more time than mothers. Fathers' time devotions have larger variability compare to mothers in both groups.

The younger group has a maximum BMI of 29 and the older children sample has a maximum BMI of 45. These two maximum scores well exceed the 95th percentile BMI-for-age cut-off points for both boys and girls.[15]

Empirical Results: Obesity-Related Health Production Function

We conducted IT3SLS and ITSUR on the triangular system. Because the focus of our study is on parental influences on children's obesity-related health outcomes, we will focus on discussing the results for production function and briefly discuss the reduced form health input demand functions results. The estimation results across the three models are similar with minor switches happening when the sample split. So we will mainly discuss the pooled model results for some key variables and compare the sub-samples results when it is needed.

Table 5 presents the detail estimation results for the pooled model and the two age groups. The IT3SLS and ITSUR results are presented side-by-side. There exist discrepancies across the two estimators overall, especially in terms of the numbers of the significant variables, although most variables have the consistent signs and magnitudes across the two estimators. As stated before, the main concern for the IT3SLS estimation is the weak instruments issue which is the common problem cross sectional studies are facing. Although we have theoretical guidance in the instruments selection, we may not

[15] According to the BMI-for-age charts developed by the National Center for Health Statistics, the 95th percentile for boys of age 11 is 23.2 and girls of age 11 is 24.1, the 95th percentile for boys of age 15 is 26.8 while for girls is 28.1.

have good data to measure them well. So we will focus on discussing those statistically significant variables in ITSUR results.

In the pooled model, four out of five parental decision variables are statistically significant. The total household monthly food expenditure, X_f, has positive impact on the child's BMI outcome. A \$100 increase in X_f leads to a 3% increase in the child's BMI.[16] Mothers' food preparation time, T_f^M , is positively related to the child's obesity-related health outcomes. Every 100 minute increase in T_f^M is associated with about a 8% increase in the children's BMI. The child's BMI in log form tends to decrease when parents spend more time with him/her. Fathers' have larger marginal influences compared to mothers: for every 100 more minutes fathers' spend with their children, the children's BMI will decrease by 8% while the same minutes increase in mothers' time with their children will bring a 3% decrease in the children's BMI. The magnitude difference is consistent with the diminishing returns to parental time inputs: as shown in Table 2, fathers on average spend less time with their children compared to mothers. We tested the paternal and maternal time impact difference. The test confirms the difference for parent-child time at 5% significance level.

The children will increase their BMI by 2% when they are one year older. Those children who participated in active exercise for 30 minutes at least one day in the past 14 days tend to have higher BMI compared to those who had no active exercise at all in the past 14 days. It may be consistent with the children's growth or may be that those exercise effects are out-weighted by the energy intake effects.[17] Parents' BMI is

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[16] The production function is in semi-log form. So the slope coefficient measures the relative change in health outcomes for a given absolute change in the value of the explanatory variable.
[17] Children who exercise more may tend to eat more afterwards.

positively correlated with the children's BMI which is consistent with the heredity effects shown in the literature.

Younger Age Group vs. Older Age Group

We will only compare and discuss those statistically significant results. Among the five parental decision variables, the fathers' and mothers' time spent with the childildren are statistically significant at 5% significance level across the two age groups and the signs are consistent. In younger group, fathers' time with their children exhibits slightly larger marginal impact on the children's BMI outcomes compared to mothers: for every 100 minutes increase in fathers' time with their children, there will be a 7.3% decrease in the children's BMI; while the same increase in mothers' time brings a 7.1% decrease in the children's BMI. The older group shows the opposite: for every 100 minutes increase in mothers' and fathers' time with their children, there will be a 6.7% and a 4.4% decrease in their children's BMI respectively. This pattern switch is consistent with diminishing returns: mothers on average spend more time with their children compared to fathers in younger group while the pattern is switched in older group. In both groups, the household monthly expenditure does not show up as a significant factor. Among parental food preparation time variables, only fathers' food preparation time is negatively correlated with the children's health outcomes in younger group. There will be a 3.6% decrease in the younger children's BMI when fathers spend 10 more minutes in food preparation.

Mothers' work-to-home spillover is significantly positively correlated with their children's health outcomes only in younger group: one-unit increase in mothers' work-to-home spillover brings about a 9.8% increase in the children's BMI. Mothers' BMI is positively correlated with the children's BMI in older group. In younger group, the more control fathers' have in terms of grocery spending amounts the lower the children's BMI is going to be. There is statistically significant difference between the marginal effects of paternal and maternal time spent with the child in either sub-group.

Empirical Results: Health Input Demand Functions

We have five reduced form demand functions for health inputs and they are final reduced form equations of the model. Theoretically, this means that the IT3SLS and ITSUR will yield similar estimation results, so in this section we will present only the ITSUR estimators.[18] Table 6, 7 and 8 report the five equation estimation results for the pooled model, the younger group, and the older group, respectively. The results are similar across three models and we will focus on the pooled model and mention the differences when it is needed.

Both parents' individual total incomes have a positive relationship with the total household monthly food expenditure. Every additional $1,000 increase in the fathers' and mothers' individual income brings about $1.65 and $1.81 increase in the total household monthly food expenditure respectively. Mother's income effect on food expenditure remains strong in younger age group while father's income effect remains strong in older age group. Fathers have more significant influence on household food expenditure compared to mothers. Fathers' work-to-home spillover level and workday flexibility level and mothers' work commitment level are positively influencing the expenditure while fathers' commitment level shows the opposite effect. The more power fathers have in terms of deciding how much to spend in grocery, the more households spent in food.

[18] The IT3SLS and ITSUR are the same in terms of signs and significance and the magnitudes only differ by a very small amounts.

The results show the complementary effect of the parents' time and money resources, i.e., the more income mothers earn, the more time fathers have to spend in food preparation (every $1,000 increase will result in a 0.28 minutes increase) while the less time mothers spent in food preparation (about 0.31 minutes decrease) which is the individual resource substitution effect. The income effect on parental child care time only show up in older age group: the more income mothers' earn, the less time mothers will spend with the child (every $1,000 increase will result in a 0.99 minute decrease). In general, mothers' show more significant influence on the parental time allocation compared to fathers: mothers' work-to-home spillover level and work commitment level are negatively influencing father-child time allocation. One puzzling fact is that mothers spend average more time with their children during their workday.[19] This result shows up in the younger age group as well while the older age group results show that fathers spend less time with their children during their workday.

Conclusion

This paper models a household with two parents and one child. The model treats the mother, the father, and the child as three separate agents with individual preferences. The parents' interaction is modeled within the collective household model framework. To capture the dynamics between the parents and the child, the parents-child interaction is modeled as a two-stage Stackleberg game where the child is allowed to have certain decision choices of his/her own. This game structure allows the parents to influence the child's health outcome separately while allowing the child to have influence in the household decision-making process.

[19] The questions are: Will mothers spend more time doing multi-tasking during workdays? Will the quality of time matter? They will be our future research topics.

A general triangular system with one child's health production equation and five reduced-form health input demand equations is derived and estimated, in order to gain both consistency and efficiency. The IT3SLS is the chosen estimation procedure for consistent and efficient results. In case of weak instruments, both ITSUR and IT3SLS results are presented to access the robustness across these estimators. The empirical estimation is performed for three systems: a pooled model, the younger children model (of age 9 to 11), and the older children model (of age 13 to 15).

The total household monthly food expenditure has positive impact on the child's BMI outcome and the impact does not show up after the sample is divided into two age groups. Both parents' time spent with the child are important and both show negatively significant impact on the child's BMI outcomes in all models and the pool model confirms the statistical difference between paternal and maternal time spent with the child. Other mother-related variables show more influence on the children's BMI: Mother's time spent in food preparation is positively related to the children's BMI in the pooled model; Mother's work-to-home stress spillover is positively related to their children's BMI in younger age group; Mother's BMI is positively related to their BMI in older age group and the pooled model.

For those health inputs demands, both parents' individual total incomes have a positive relationship with the total household monthly food expenditure. There exists a complementary relationship between mothers' income and fathers' time allocation. Fathers have more significant influence on household food expenditure compared to mothers. The individual resource substitution effect shows in older age group: mothers' income is negatively related to their time spent with the children. In general, mothers' show more significant influence on the parental time allocation compared to fathers.

The main contribution of this study is that it develops a general theoretical framework to capture the dynamics between the parents and the child. Based on this theoretical model, empirical analysis and future research can be conducted in a theoretically consistent way.

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APPENDIX

Table 1. Variable Description

Variable	Description	Unit
Dependent Variables (LHS Variables in the triangular system)		
TotExp	Total household monthly food expenditure (FAH+Takeout+FAFH)	Dollars/month
FatherPrepTime	Father's time spent in food preparation (prepare meal, drink, cleanup, takeout purchase)	Minutes/day
MotherPrepTime	Mother's time spent in food preparation	Minutes/day
FatherChildTime	Father's time spent with the child	Minutes/day
MotherChildTime	Mother's time spent with the child	Minutes/day
KidBMI	The Child's Body Mass Index	Kilograms/meters^2
Independent Variables (RHS Variables in the triangular system)		
Economic Variables		
FatherIncome	Father's individual total income (earned + unearned)	Dollars/year
MotherIncome	Mother's total income (earned + unearned)	Dollars/year
FatherTime	Father's total non-work time	Minutes/day
MotherTime	Mother's total non-work time	Minutes/day
FatherWorkDay	Father's working day indicator: 1 if it is the working-day pattern; 0 otherwise	0 or 1
MotherWorkDay	Mother's working day indicator: 1 if it is the working-day pattern; 0 otherwise	0 or 1
Sociological Variables		
FatherSpillover	Father's work-to-home spillover	Factor
MotherSpillover	Mother's work-to-home spillover	Factor
FatherHR	Father's work hour flexibility – 1 is inflexible; 2 is somewhat flexible; 3 is very flexible	Rank
MotherHR	Mother's work hour flexibility – 1 is inflexible; 2 is somewhat flexible; 3 is very flexible	Rank
FatherDay	Father's work day flexibility – 1 is inflexible; 2 is somewhat flexible; 3 is very flexible	Rank
MotherDay	Mother's work day flexibility – 1 is inflexible; 2 is somewhat flexible; 3 is very flexible	Rank
FatherCommit	Father's commitment to work – 1 to 5 means work is of increasing priority in life	Rank
MotherCommit	Mother's commitment to work – 1 to 5 means work is of increasing priority in life	Rank
Control Variables		
Age	Child's age	Year
Gender	Child's gender – 1 is for male; 0 is for female	0 or 1
White	Child's ethnicity – 1 is for white; 0 otherwise	0 or 1
Hispanic	Child's ethnicity – 1 is for Hispanic; 0 otherwise	0 or 1
Puberty	Child 's Puberty Stage – 1 if pubescent; 0 for pre-pubescent	0 or 1
Sibling	The number of siblings in the household	Number
Activity1	Child's active exercise frequency in the last 14 days: 1 if 1 to 2 days; 0 if not	0 or 1
Activity2	Child's active exercise frequency in the last 14 days: 1 if 3 to 5 days; 0 if not	0 or 1
Activity3	Child's active exercise frequency in the last 14 days: 1 if 6 to 8 days; 0 if not	0 or 1
Activity4	Child's active exercise frequency in the last 14 days: 1 if 9 or more days; 0 if not	0 or 1
FatherBMI	Father's Body Mass Index	Kilograms/meters^2
MotherBMI	Mother's Body Mass Index	Kilograms/meters^2
FatherEdu	Father’s education level: grades completed	Rank
MotherEdu	Mother’s education level: grades completed	Rank
FatherActive	Father’s active level: 1 to 3 means decreasing active lifestyle	Rank
MotherActive	Mother’s active level: 1 to 3 means decreasing active lifestyle	Rank
ToBuy	Father and mother decision power difference in "whether to buy groceries"	Categories
ToSpend	Father and mother decision power difference in "how much to spend on groceries"	Categories

Table 2. Summary Statistics for Pooled Model

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Dependent Variables (LHS Variables in the triangular system)					
TotExp	125	690.64	234.30	210.00	1579.00
FatherPrepTime	125	19.92	24.39	0	114.50
MotherPrepTime	125	65.26	54.17	0	314.50
FatherChildTime	125	79.45	112.71	0	967.00
MotherChildTime	125	90.47	92.19	0	479.50
KidBMI	125	20.67	4.69	14.35	45.10
Independent Variables (RHS Variables in the triangular system)					
Economic Variables					
FatherIncome	125	77960.90	52834.26	1200.00	370000.00
MotherIncome	125	32636.60	34118.96	1125.00	212750.00
FatherTime	125	1001.34	206.00	547.50	1440.00
MotherTime	125	1136.88	213.46	690.00	1440.00
FatherWorkDay	125	0.90	0.31	0	1.00
MotherWorkDay	125	0.80	0.40	0	1.00
Sociological Variables					
FatherSpillover	125	-0.05	0.89	-1.85	2.63
MotherSpillover	125	0.09	0.76	-1.36	2.34
FatherHR	125	2.23	0.67	1.00	3.00
MotherHR	125	2.05	0.81	1.00	3.00
FatherDay	125	1.77	0.82	1.00	3.00
MotherDay	125	1.74	0.82	1.00	3.00
FatherCommit	125	2.43	1.03	1.00	5.00
MotherCommit	125	1.91	0.80	1.00	4.00
Control Variables					
Age	125	12.27	2.14	9.00	15.00
Gender	125	0.49	0.50	0	1.00
White	125	0.79	0.41	0	1.00
Hispanic	125	0.11	0.32	0	1.00
Puberty	125	0.88	0.33	0	1.00
Sibling	125	1.00	0.80	0	1.00
Activity1	125	0.18	0.39	0	1.00
Activity2	125	0.25	0.43	0	1.00
Activity3	125	0.26	0.44	0	1.00
Activity4	125	0.26	0.44	0	1.00
FatherBMI	125	27.38	3.66	17.63	36.28
MotherBMI	125	25.13	5.00	18.09	46.20
FatherEdu	125	5.88	1.35	3.00	8.00
MotherEdu	125	6.00	1.24	4.00	8.00
FatherActive	125	1.60	0.64	1.00	3.00
MotherActive	125	1.76	0.70	1.00	3.00
ToBuy	125	0.23	0.82	-2.00	2.00
ToSpend	125	0.24	0.82	-2.00	2.00

Variable definitions can be found in Appendix Table 1.

Table 3. Summary Statistics for Children Ages 9 to 11

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Dependent Variables (LHS Variables in the triangular system)					
TotExp	59	674.35	232.22	210.00	1579.00
FatherPrepTime	59	15.13	19.98	0	80.00
MotherPrepTime	59	64.89	44.12	0	202.50
FatherChildTime	59	80.13	78.68	0	419.00
MotherChildTime	59	111.70	96.61	0	479.50
KidBMI	59	18.98	3.72	14.35	28.71
Independent Variables (RHS Variables in the triangular system)					
Economic Variables					
FatherIncome	59	79720.08	56609.28	13356.00	370000.00
MotherIncome	59	29166.46	32958.97	1125.00	160000.00
FatherTime	59	999.02	215.57	547.50	1440.00
MotherTime	59	1165.94	212.73	825.00	1440.00
FatherWorkDay	59	0.90	0.30	0	1.00
MotherWorkDay	59	0.80	0.41	0	1.00
Sociological Variables					
FatherSpillover	59	-0.05	0.98	-1.66	2.63
MotherSpillover	59	0.03	0.74	-1.36	1.86
FatherHR	59	2.24	0.73	1.00	3.00
MotherHR	59	2.04	0.79	1.00	3.00
FatherDay	59	1.90	0.88	1.00	3.00
MotherDay	59	1.76	0.82	1.00	3.00
FatherCommit	59	2.51	1.04	1.00	5.00
MotherCommit	59	1.85	0.78	1.00	4.00
Control Variables					
Age	59	10.17	0.79	9.00	11.00
Gender	59	0.44	0.50	0	1.00
White	59	0.75	0.44	0	1.00
Hispanic	59	0.17	0.38	0	1.00
Puberty	59	0.76	0.43	0	1.00
Sibling	59	1.07	0.81	0	4.00
Activity1	59	0.17	0.38	0	1.00
Activity2	59	0.27	0.45	0	1.00
Activity3	59	0.32	0.47	0	1.00
Activity4	59	0.19	0.39	0	1.00
FatherBMI	59	27.10	3.46	20.08	35.95
MotherBMI	59	24.35	3.89	18.09	41.20
FatherEdu	59	5.89	1.32	3.00	8.00
MotherEdu	59	5.97	1.20	4.00	8.00
FatherActive	59	1.61	0.64	1.00	3.00
MotherActive	59	1.71	0.62	1.00	3.00
ToBuy	59	0.20	0.76	-2.00	2.00
ToSpend	59	0.19	0.86	-2.00	2.00

Variable definitions can be found in Appendix Table 1.

Table 4. Summary Statistics for Children Ages 13 to 15

Variable	N	Mean	Std. Dev.	Minimum	Maximum
Dependent Variables (LHS Variables in the triangular system)					
TotExp	66	705.20	236.97	250.00	1460.00
FatherPrepTime	66	24.21	27.19	0	114.50
MotherPrepTime	66	65.59	62.14	0	314.50
FatherChildTime	66	78.84	136.78	0	967.00
MotherChildTime	66	71.50	84.33	0	442.50
KidBMI	66	22.19	4.96	14.80	45.10
Independent Variables (RHS Variables in the triangular system)					
Economic Variables					
FatherIncome	66	76388.30	49602.69	1200.00	283044.00
MotherIncome	66	35738.70	35081.92	2400.00	212750.00
FatherTime	66	1003.42	198.69	607.50	1440.00
MotherTime	66	1110.91	212.34	690.00	1440.00
FatherWorkDay	66	0.89	0.31	0	1.00
MotherWorkDay	66	0.80	0.40	0	1.00
Sociological Variables					
FatherSpillover	66	-0.05	0.82	-1.85	2.19
MotherSpillover	66	0.13	0.79	-1.31	2.34
FatherHR	66	2.23	0.63	1.00	3.00
MotherHR	66	2.02	0.85	1.00	3.00
FatherDay	66	1.65	0.73	1.00	3.00
MotherDay	66	1.73	0.83	1.00	3.00
FatherCommit	66	2.36	1.03	1.00	5.00
MotherCommit	66	1.97	0.82	1.00	4.00
Control Variables					
Age	66	14.12	0.81	13.00	15.00
Gender	66	0.53	0.50	0	1.00
White	66	0.83	0.38	0	1.00
Hispanic	66	0.06	0.24	0	1.00
Puberty	66	0.98	0.12	0	1.00
Sibling	66	0.94	0.80	0	3.00
Activity1	66	0.20	0.40	0	1.00
Activity2	66	0.23	0.42	0	1.00
Activity3	66	0.20	0.40	0	1.00
Activity4	66	0.33	0.48	0	1.00
FatherBMI	66	27.63	3.83	17.63	36.28
MotherBMI	66	25.82	5.75	18.88	46.20
FatherEdu	66	5.86	1.38	3.00	8.00
MotherEdu	66	6.03	1.29	4.00	8.00
FatherActive	66	1.59	0.63	1.00	3.00
MotherActive	66	1.82	0.76	1.00	3.00
ToBuy	66	0.26	0.88	-2.00	2.00
ToSpend	66	0.29	0.78	-1.00	2.00

Variable definitions can be found in Appendix Table 1.

Table 5. The Obesity-Related Health Production Function Results

	Pooled Model		Age 9 to 11		Age 13 to 15	
Variables	IT3SLS	ITSUR	IT3SLS	ITSUR	IT3SLS	ITSUR
Intercept	1.65*	1.67*	2.58*	2.59*	1.12	1.34**
	(0.48)	(0.30)	(0.70)	(0.59)	(0.74)	(0.74)
TotExp	2.75E-04	3.04E-04*	1.32E-04	1.39E-04	-0.14E-03	0.20E-03
	(1.90E-04)	(0.72E-05)	(2.09E-04)	(0.89E-04)	(2.24E-04)	(1.38E-04)
FatherPrepTime	-2.4E-04	4.80E-04	-3.68E-03	-3.58E-03*	-0.43E-03	-5.08-06
	(2.33E-03)	(6.69E-04)	(3.20E-03)	(1.17E-03)	(2.81E-03)	(8.96E-04)
MotherPrepTime	5.73E-04	7.50E-04*	5.31E-04	5.57E-04	1.16E-03	1.53E-03*
	(7.90E-04)	(3.12E-04)	(1.12E-03)	(5.51E-04)	(7.83E-04)	(4.03E-04)
FatherChildTime	-5.30E-04	-0.79E-03*	-0.68E-03	-0.73E-03*	-0.09E-03	-0.44E-04*
	(5.39E-04)	(1.41E-04)	(7.21E-04)	(2.56E-04)	(4.89E-04)	(1.79E-04)
MotherChildTime	-2.90E-04	-0.33E-03**	-0.67E-03	-0.71E-03*	-0.29E-03	-0.67E-03*
	(8.15E-04)	(1.88E-04)	(7.33E-04)	(2.40E-04)	(8.07E-04)	(3.12E-04)
FatherSpillover	-0.03	-0.03	-0.045	-0.05	-0.03	-0.02
	(0.03)	(0.03)	(0.04)	(0.03)	(0.04)	(0.04)
MotherSpillover	0.04	0.04	0.10	0.10*	-4.46E-03	-0.03
	(0.03)	(0.03)	(0.07)	(0.05)	(0.05)	(0.05)
Age	0.03**	0.02**	-0.01	-0.01	0.07**	0.07**
	(0.01)	(0.01)	(0.05)	(0.04)	(0.04)	(0.04)
Gender	0.04	0.04	0.15**	0.15*	-0.05	-0.07
	(0.04)	(0.04)	(0.08)	(0.06)	(0.07)	(0.06)
White	-0.05	-0.05	-0.01	0.01	-0.05	-0.02
	(0.08)	(0.07)	(0.11)	(0.10)	(0.10)	(0.11)
Hispanic	-0.08	-0.09	-0.12	-0.13	-0.16	-0.14
	(0.10)	(0.10)	(0.14)	(0.13)	(0.14)	(0.16)
Sibling	0.04	0.04	0.04	0.04	0.04	0.05
	(0.03)	(0.03)	(0.05)	(0.04)	(0.04)	(0.05)
Puberty	0.09	0.09	0.08	0.08	0.09	0.08
	(0.07)	(0.07)	(0.08)	(0.07)	(0.22)	(0.25)
FatherEdu	1.45E-03	-5.02E-03	-0.02	-0.02	9.87E-03	0.94E-04
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.03)
MotherEdu	-5.29E-03	-6.92E-03	-0.04	-0.04	0.03	0.04
	(0.02)	(0.02)	(0.04)	(0.03)	(0.03)	(0.03)
FatherActive	-0.02	-0.02	-0.02	-0.02	-0.03	-0.05
	(0.04)	(0.04)	(0.05)	(0.04)	(0.06)	(0.06)
MotherActive	0.04	0.04	0.03	0.03	-0.04	-0.02
	(0.05)	(0.04)	(0.06)	(0.05)	(0.07)	(0.06)
Activity1	0.26*	0.27*	0.32**	0.32*	0.18	0.20
	(0.11)	(0.11)	(0.16)	(0.14)	(0.19)	(0.19)
Activity2	0.25*	0.26*	0.17	0.17	0.33*	0.38*
	(0.12)	(0.11)	(0.16)	(0.13)	(0.19)	(0.18)
Activity3	0.29*	0.31*	0.30**	0.30*	0.27	0.32**
	(0.11)	(0.11)	(0.17)	(0.14)	(0.20)	(0.18)
Activity4	0.26*	0.29*	0.24	0.24	0.17	0.20
	(0.13)	(0.11)	(0.17)	(0.15)	(0.20)	(0.17)
FatherBMI	0.01	0.01**	7.67E-03	7.70E-03	8.95E-03	8.06E-03
	(7.54E-03)	(6.26E-03)	(8.55E-03)	(8.07E-03)	(8.25E-03)	(8.90E-03)
MotherBMI	9.87E-03*	9.90E-03*	9.65E-03	9.59E-03	0.01**	0.01**
	(4.86E-03)	(4.87E-03)	(8.47E-03)	(8.21E-03)	(6.14E-03)	(6.54E-03)
ToBuy	-0.02	-0.02	0.01	0.01	-0.04	-0.05
	(0.03)	(0.03)	(0.05)	(0.05)	(0.05)	(0.05)
ToSpend	-0.04	-0.04	-0.10*	-0.10*	0.05	0.07
	(0.04)	(0.03)	(0.05)	(0.04)	(0.07)	(0.06)

Note: Numbers in (.) are standard errors; * : 5% significance level; **: 10% significance level. Variable definitions can be found in Appendix Table 1.

Table 6. Health Input Demand Results (ITSUR): Pooled Model

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
Intercept	342.80	-3.05	181.67**	33.46	235.66
	(409.99)	(46.76)	(97.00)	(201.29)	(172.30)
FatherIncome	1.65E-03*	-7.00E-05	2.42E-06	2.98E-04	-1.20E-04
	(4.12E-04)	(4.80E-05)	(1.00E-04)	(1.92E-04)	1.78E-04
MotherIncome	1.81E-03*	2.77E-04*	-3.10E-04**	3.19E-04	-4.40E-04
	(7.27E-04)	(8.50E-05)	(1.77E-04)	(3.40E-04)	3.15E-04
FatherSpillover	64.05*	2.49	4.33	7.14	12.84
	(25.92)	(2.84)	(5.88)	(13.50)	(10.45)
MotherSpillover	-9.95	-2.60	-5.59	-31.43**	16.17
	(31.40)	(3.44)	(7.14)	(16.33)	(12.67)
FatherHR	-22.49	2.78	-7.94	-29.15**	-4.20
	(33.80)	(4.00)	(8.30)	(15.53)	(14.76)
FatherDay	62.98*	-0.68	8.23	-4.13	5.82
	(29.14)	(3.45)	(7.16)	(13.40)	(12.72)
MotherHR	-28.38	-1.14	-8.96	-15.01	21.10
	(29.84)	(3.52)	(7.32)	(13.76)	(13.01)
MotherDay	18.77	3.87	5.76	34.45*	-2.62
	(32.93)	(3.89)	(8.08)	(15.15)	(14.37)
FatherCommit	-38.65**	-5.03*	-6.00	-5.46	5.03
	(20.65)	(2.44)	(5.06)	(9.55)	(8.99)
MotherCommit	49.45*	-1.70	10.75**	-28.31*	6.85
	(24.28)	(2.87)	(5.96)	(11.18)	(10.60)
Gender	-72.34**	1.31	-0.71	4.63	16.30
	(43.52)	(4.76)	(9.86)	(22.72)	(17.50)
White	15.27	11.32	-15.00	2.65	30.93
	(74.84)	(8.22)	(17.04)	(38.85)	(30.24)
Hispanic	134.25	14.13	-14.01	17.24	-12.98
	(93.04)	(10.12)	(20.98)	(48.89)	(37.23)
Age	7.52	1.78	4.97*	0.45	-4.72
	(11.15)	(1.22)	(2.52)	(5.84)	(4.47)
Puberty	10.06	7.48	-19.78	-10.95	-43.30
	(73.95)	(8.09)	(16.77)	(38.56)	(29.77)
Sibling	17.21	-4.85	-3.19	-15.53	18.69**
	(27.42)	(2.98)	(6.18)	(14.42)	(10.97)

Table 6. Continued

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
FatherEdu	-1.07	0.31	-0.50	-13.52	-7.10
	(17.03)	(1.85)	(3.83)	(8.98)	(6.79)
MotherEdu	-0.87	-2.09	-4.04	-3.86	1.15
	(21.59)	(2.37)	(4.92)	(11.19)	(8.73)
FatherActive	5.58	-5.92	0.75	-38.55*	11.19
	(36.62)	(3.99)	(8.27)	(19.21)	(14.67)
Motheractive	3.14	4.99	-18.36*	47.14*	-35.54*
	(37.16)	(4.09)	(8.47)	(19.26)	(15.03)
Activity1	-29.58	6.25	-12.16	89.03	-24.99
	(108.53)	(11.88)	(24.61)	(56.62)	(43.68)
Activity2	-46.54	0.73	-4.27	92.95**	-53.81
	(107.60)	(11.74)	(24.32)	(56.36)	(43.17)
Activity3	44.81	-4.07	-6.92	72.25	-32.69
	(105.33)	(11.49)	(23.80)	(55.20)	(42.24)
Activity4	-48.44	-4.18	-21.34	97.63**	-58.67
	(108.75)	(11.89)	(24.65)	(56.78)	(43.74)
FatherBMI	-6.48	-0.10	-1.55	2.18	-4.32**
	(6.10)	(0.67)	(1.38)	(3.19)	(2.45)
MotherBMI	-0.96	-0.78	-0.83	-1.56	0.13
	(4.72)	(0.51)	(1.07)	(2.48)	(1.89)
FatherTime	0.10	0.02	-0.05	0.10	-0.04
	(0.14)	(0.02)	(0.03)	(0.06)	(0.06)
MotherTime	0.03	0.01	0.08*	0.04	0.10
	(0.14)	(0.02)	(0.03)	(0.06)	(0.06)
ToBuy	-25.54	2.09	-2.52	-17.43	-0.24
	(29.78)	(3.23)	(6.69)	(15.72)	(11.88)
ToSpend	85.73*	-0.27	4.58	-0.85	12.75
	(31.97)	(3.49)	(7.22)	(16.76)	(12.82)
FatherWorkDay	115.55	-9.82	-36.75	-31.70	-22.95
	(97.27)	(11.50)	(23.88)	(44.76)	(42.44)
MotherWorkDay	-15.27	4.20	-8.10	13.93	53.60**
	(68.26)	(8.08)	(16.77)	(31.37)	(29.80)

Note: Numbers in (.) are standard errors; * : 5% significance level; **: 10% significance level.
Variable definitions can be found in Appendix Table 1.

Table 7. Health Input Demand Results (ITSUR): Age 9 to 11 Model

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
Intercept	783.81	83.79	68.74	438.26	-28.36
	(1043.78)	(83.23)	(156.99)	(361.49)	(384.85)
FatherIncome	1.07E-03	-1.30E-04**	-1.30E-04	4.58E-04	-2.40E-04
	(8.21E-04)	(6.70E-05)	(1.26E-04)	(2.77E-04)	(2.95E-04)
MotherIncome	4.74E-03*	8.70E-05	-8.00E-05	2.33E-04	-1.50E-04
	(1.68E-03)	(1.37E-04)	(2.60E-04)	(5.67E-04)	(6.02E-04)
FatherSpillover	83.90	-0.64	-7.81	20.75	32.78
	(58.02)	(4.62)	(8.72)	(20.12)	(21.42)
MotherSpillover	-83.50	0.30	-14.98	21.04	28.15
	(78.75)	(6.26)	(11.79)	(27.39)	(29.17)
FatherHR	27.15	-1.48	-3.35	-20.07	-17.11
	(66.57)	(5.46)	(10.34)	(22.31)	(23.66)
FatherDay	54.58	4.34	-1.62	-5.55	9.61
	(55.94)	(4.58)	(8.67)	(18.78)	(19.92)
MotherHR	-58.25	0.39	-12.66	-13.51	-3.08
	(65.23)	(5.34)	(10.10)	(21.95)	(23.29)
MotherDay	16.26	-0.61	23.02*	35.82	-6.06
	(69.03)	(5.64)	(10.66)	(23.27)	(24.70)
FatherCommit	-82.62	-2.60	-2.17	-26.11	-11.35
	(50.24)	(4.11)	(7.77)	(16.91)	(17.95)
MotherCommit	80.51	-6.28	7.89	-24.84	-1.17
	(57.53)	(4.69)	(8.88)	(19.43)	(20.62)
Gender	-69.85	9.81	-2.75	14.43	52.14
	(101.49)	(8.04)	(15.15)	(35.41)	(37.73)
White	-169.15	14.98	15.35	2.21	-29.84
	(148.91)	(11.73)	(22.09)	(52.24)	(55.70)
Hispanic	-110.92	-3.72	8.90	19.57	-106.44
	(195.45)	(15.41)	(29.02)	(68.50)	(73.02)
Age	17.00	-0.47	16.45**	-25.81	14.92
	(61.95)	(4.89)	(9.21)	(21.69)	(23.12)
Puberty	-47.23	6.48	-24.26	27.44	-28.78
	(113.26)	(8.95)	(16.86)	(39.60)	(42.21)
Sibling	-78.58	-1.72	-0.80	1.93	-8.83
	(66.39)	(5.24)	(9.87)	(23.25)	(24.78)

Table 7. Continued

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
FatherEdu	-17.77	-2.64	-2.44	-5.07	-17.44
	(32.60)	(2.56)	(4.81)	(11.49)	(12.26)
MotherEdu	-39.22	-6.49	-8.12	-8.92	-14.64
	(53.12)	(4.21)	(7.93)	(18.52)	(19.74)
FatherActive	-21.34	-4.40	2.86	-40.40**	16.29
	(62.90)	(4.94)	(9.30)	(22.12)	(23.59)
Motheractive	-34.84	-2.20	-14.05	5.59	-45.93
	(79.31)	(6.27)	(11.81)	(27.73)	(29.55)
Activity1	-130.02	34.20*	-3.53	125.36**	-33.95
	(195.79)	(15.37)	(28.95)	(68.88)	(73.46)
Activity2	359.40**	18.76	28.43	93.16	-59.67
	(181.61)	(14.24)	(26.81)	(63.98)	(68.24)
Activity3	-167.85	17.94	30.79	79.17	-58.09
	(199.12)	(15.65)	(29.48)	(69.98)	(74.63)
Activity4	-184.41	13.67	6.24	61.27	-64.39
	(205.67)	(16.13)	(30.36)	(72.46)	(77.29)
FatherBMI	-3.97	-0.04	-3.00	2.61	-3.84
	(12.02)	(0.95)	(1.78)	(4.21)	(4.49)
MotherBMI	5.14	-1.85**	0.90	-1.77	-1.90
	(11.88)	(0.93)	(1.75)	(4.18)	(4.46)
FatherTime	0.07	0.01	-0.07	0.16	0.20**
	(0.29)	(0.02)	(0.05)	(0.10)	(0.11)
MotherTime	0.31	0.02	0.07	-0.14	0.23*
	(0.28)	(0.02)	(0.04)	(0.10)	(0.10)
ToBuy	-39.83	-2.43	0.16	-2.78	-34.84
	(70.93)	(5.58)	(10.50)	(24.92)	(26.57)
ToSpend	36.13	-3.60	2.33	-14.73	14.29
	(57.72)	(4.54)	(8.54)	(20.29)	(21.64)
FatherWorkDay	33.80	-12.21	-59.23	25.66	27.33
	(186.21)	(15.23)	(28.81)	(62.67)	(66.49)
MotherWorkDay	-61.29	18.46	2.30	-34.80	104.14*
	(141.19)	(11.55)	(21.84)	(47.52)	(50.42)

Note: Numbers in (.) are standard errors; * : 5% significance level; **: 10% significance level.
Variable definitions can be found in Appendix Table 1.

Table 8. Health Input Demand Results (ITSUR): Age 13 to 15 Model

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
Intercept	736.14	-26.20	204.40	-917.03	346.92
	(848.98)	(147.12)	(307.19)	(694.45)	(407.72)
FatherIncome	3.24E-03*	-9.00E-05	2.70E-05	-1.60E-04	-2.50E-04
	(5.99E-04)	(1.04E-04)	(2.16E-04)	(4.81E-04)	(2.86E-04)
MotherIncome	7.07E-04	2.02E-04	-8.20E-04*	-9.00E-05	-9.90E-04*
	(9.74E-04)	(1.69E-04)	(3.47E-04)	(7.54E-04)	(4.58E-04)
FatherSpillover	71.24**	-5.32	1.94	-29.05	-5.67
	(36.71)	(6.35)	(13.58)	(32.17)	(18.15)
MotherSpillover	-27.64	-1.29	4.81	-52.11	-14.39
	(37.82)	(6.54)	(14.03)	(33.44)	(18.77)
FatherHR	-92.00**	1.61	-12.52	-27.77	-16.10
	(49.15)	(8.53)	(17.41)	(37.33)	(22.94)
FatherDay	93.07*	-4.33	12.60	-20.44	-3.38
	(41.70)	(7.23)	(14.77)	(31.71)	(19.47)
MotherHR	40.37	-4.22	-4.90	-51.05	31.20
	(40.25)	(6.98)	(14.28)	(30.77)	(18.83)
MotherDay	-38.23	7.15	-7.38	68.58**	-25.84
	(45.72)	(7.93)	(16.23)	(34.99)	(21.40)
FatherCommit	-39.56	-6.98	-10.36	17.28	6.50
	(27.82)	(4.83)	(9.87)	(21.24)	(13.01)
MotherCommit	21.92	3.02	33.17*	-59.19*	-0.84
	(38.31)	(6.65)	(13.57)	(29.09)	(17.88)
Gender	-121.56*	-1.22	-7.93	13.67	-37.58
	(47.53)	(8.22)	(17.72)	(42.64)	(23.74)
White	-36.90	1.88	-49.58	3.84	34.72
	(103.49)	(17.92)	(37.91)	(88.05)	(50.51)
Hispanic	148.23	-2.59	-41.75	-27.05	-13.38
	(130.43)	(22.57)	(48.25)	(114.34)	(64.49)
Age	-57.81	6.17	-4.33	57.90**	4.64
	(37.23)	(6.45)	(13.65)	(31.77)	(18.20)
Puberty	96.68	-3.15	18.30	-68.45	6.13
	(199.79)	(34.56)	(74.22)	(177.42)	(99.34)
Sibling	83.12*	-6.28	-10.19	-31.74	3.27
	(36.23)	(6.27)	(13.47)	(32.25)	(18.03)

Table 8. Continued

Variables	TotExp	FatherPrepTime	MotherPrepTime	FatherChildTime	MotherChildTime
FatherEdu	-0.66	5.60	9.08	-2.18	10.39
	(22.15)	(3.83)	(8.20)	(19.48)	(10.96)
MotherEdu	10.13	-2.00	-7.53	7.11	3.04
	(24.32)	(4.21)	(9.02)	(21.47)	(12.06)
FatherActive	7.01	1.44	5.79	-21.38	-8.15
	(49.63)	(8.59)	(18.43)	(44.02)	(24.66)
Motheractive	108.87*	-1.98	-26.15	18.93	-60.39*
	(53.83)	(9.32)	(19.74)	(45.95)	(26.31)
Activity1	44.63	-36.39	-56.62	60.94	-54.12
	(168.20)	(29.12)	(61.79)	(144.37)	(82.40)
Activity2	151.85	-33.36	-56.67	100.33	-64.99
	(149.40)	(25.85)	(55.28)	(131.09)	(73.89)
Activity3	236.46	-47.62	-90.20	31.15	-58.59
	(167.63)	(29.02)	(61.52)	(143.50)	(82.03)
Activity4	54.35	-35.29	-67.39	88.30	-106.41
	(152.04)	(26.32)	(55.98)	(131.41)	(74.71)
FatherBMI	-0.62	-0.30	-1.51	4.33	-1.86
	(7.74)	(1.34)	(2.85)	(6.70)	(3.80)
MotherBMI	-9.18	-0.42	-0.47	1.19	0.58
	(5.65)	(0.98)	(2.08)	(4.90)	(2.78)
FatherTime	0.08	0.01	-0.03	0.00	-0.22*
	(0.21)	(0.04)	(0.07)	(0.16)	(0.10)
MotherTime	0.09	0.02	0.14**	0.25	0.08
	(0.20)	(0.03)	(0.07)	(0.15)	(0.09)
ToBuy	-61.06**	6.43	6.71	-27.74	11.24
	(33.61)	(5.81)	(12.50)	(29.91)	(16.73)
ToSpend	105.33*	5.73	9.92	21.46	28.49
	(43.95)	(7.61)	(16.20)	(38.15)	(21.64)
FatherWorkDay	211.12	-24.79	-12.58	-184.69**	-67.73
	(143.32)	(24.86)	(50.92)	(110.09)	(67.17)
MotherWorkDay	18.95	6.62	12.15	104.29	49.50
	(101.89)	(17.68)	(36.06)	(77.21)	(47.52)

Note: Numbers in (.) are standard errors; * : 5% significance level; **: 10% significance level.
Variable definitions can be found in Appendix Table 1.