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ESTIMATION OF HEALTH DEMAND AND HEALTH PRODUCTION FUNCTIONS FOR CHILDREN IN BRAZIL

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1. INTRODUCTION

An estimated 800 million people, 20% of the population in developing countries, suffer from the consequences of inadequate food consumption. Growth failure affects one-third of the preschool children in these countries.[1] There is a rapidly growing body of literature which analyzes the factors that affect nutrition and health outcomes.[2] It is particularly relevant to utilize Brazilian data to study these issues. Brazil has a poorer record on nutrition and health than do many other countries at a comparable level of income per capita, and one that is worse than some countries at much lower economic levels.[3]

This study estimates reduced-form health demand equations and health production functions for infants (up to 12 months old) and preschool children (2-5 years old) in Brazil. The demand equations provide information on how exogenous factors affect the child's health status, which can be used to orient government policies. However, the structural process of how inputs affect the child's health cannot be observed unless a production function is estimated.

A major contribution of this analysis is the inclusion of the parents' opportunity costs of time, as measured by their estimated wage rates, as a determinant in the demand equations. The concept of full income, which is derived from the original household model of Gary Becker, is also empirically implemented.[4]

Due to the richness of the data available, the demand equations could also include variables for key characteristics of the child and parents, region and urbanization, plus a set of important infrastructure factors. A range of inputs covering the child's characteristics, household capital, government programs, parents' heights, and the mother's education and time allocation could be included in the production functions. The health production function for infants also contains breast-feeding status and factors affecting the mother's health.

Efforts were made to avoid the estimation of a quasi-reduced form equation (a combination of production and demand functions), which unfortunately has been common in the literature, but makes the interpretation of the results very difficult. A two-stage least-squares method was applied to estimate the health production functions as a way to control for the endogeneity of some explanatory variables. Past studies, in particular Thomas, Strauss, and Henriques and Thomas and Strauss, that analyzed the determinants of children's health in Brazil were based on a household socioeconomic survey (ENDEF) carried out in 1974/75.[5] This present study uses the more recent 1989 National Health and Nutrition Survey.

2. ANALYTICAL FRAMEWORK

2.1. Theoretical Model

This analysis is based on a household model with constrained maximization of a joint utility function.[6] It is assumed that the household behaves as if it maximizes a utility function, which is a function of the commodities consumed, health status of the infants, children, and adults, and leisure time of the adults.

The health of the infant (H^I) is produced by the infant feeding methods (C^I), i.e., breast-feeding, bottle feeding and supplemental food; health inputs (Y^I), such as medical care; mother's health (H^m), which affects the infant's health through, for example, her consumption of cigarettes and alcoholic beverages; adult's leisure time (l^a) which includes time for child care; individual and household characteristics (Z); and by attributes that are not observed (u_1).[7]

$$H^I = H^I(C^I, Y^I, H^m, l^a; Z, u_1)$$

The health of the child (H^{ch}) is produced by the commodities consumed (C^{ch}), where milk is considered a very important one; health inputs (Y^{ch}), l^a and Z described above; and by attributes that are not observed (u_2).

$$H^{ch} = H^{ch}(C^{ch}, Y^{ch}, l^a; Z, u_2)$$

Maximization of the utility function subject to the health production functions and full income constraint, which is derived from the time and income constraints, yields the following reduced-form demand functions for the vector of commodities consumed (C), health inputs (Y), leisure (l), and health (H):

$$C, Y, l, H = D^i(P_C, P_Y, W, S, Z, e) \qquad i = C, Y, l, H$$

where P_c and P_y represent vectors of prices for commodities and health inputs, W is a vector of market wage rates, S is full income, Z represents individual and household characteristics and ϵ is a vector of unobserved attributes.

2.2. Estimation Procedure

Reduced-form health demand equations are estimated by ordinary least squares (OLS) since only exogenous variables are present on the right-hand-side of the equations. On the other hand, health production functions are more susceptible to simultaneous equations bias, since some of the explanatory variables are subject to individual choice. A Hausman test showed the presence of correlation between explanatory variables and the error term, and therefore, a two-stage least-squares procedure (2SLS) was employed. In the first stage, each endogenous variable was regressed as a function of all the exogenous variables by probit or OLS, depending on whether the dependent variable was binary or continuous. The exogenous variables used as instruments were the same explanatory variables as in the reduced-form demand equations. The estimates of the endogenous variables were used as right-hand-side variables in the production functions and OLS was applied to estimate the coefficients.

Although a longitudinal data set was not available to permit better control of unobserved genetic endowments, information on parents' heights was available and was used as a measure of genetic characteristics.[8] Data on prices were not available, but region and urbanization were included and partially reflect price differences.

3. SURVEY DATA AND VARIABLES

The data set used is the 1989 National Health and Nutrition Survey, undertaken by the Brazilian Geographical and Statistical Institute (IBGE), Institute of Social Economic Planning (IPEA) and by the National Institute of Food and Nutrition (INAN). The data were collected between July and September of 1989. Approximately 63,000 individuals were interviewed from 17,920 households. For this study, only children from 0 to 5 years old who were related to family members in the household were selected from the survey, which yielded a basic sample of 7,544 children.

3.1. Health-Nutritional Status Variables

The health status of the preschool children, from 2 to 5 years old, and infants, from 0 to 12 months old, is measured by anthropometric Z-scores. Children suffering from severe, moderate and mild malnutrition can be classified according to their Z-score values.[9] These results are presented for preschool children in table 1. The Z-scores of height-for-age, in part A, indicate chronic malnutrition, called stunting while the Z-scores of weight-for-height, in part B, represent an acute type called wasting. Weight-for-age, in part C, does not differentiate between acute and chronic malnutrition and is now less frequently used.

In table 1, stunting is the more crucial problem with 16% of the sample suffering from severe and moderate malnutrition. Stunting is frequently found to be associated with poor overall economic conditions, repeated infections and prolonged inadequate nutrient intake.[10] The regions are Northeast, Southeast, South, and Central and the sectors are urban and rural. Nutritional problems are worse in the Northeast and in rural areas.

A measure of the degree of malnutrition among infants is presented in table 2. The highest percentages of undernourished infants are also found in the Northeast and in rural areas. As with preschool children, the problem of infant malnutrition is more chronic or long-run than acute or short-run. The Z-scores of weight-for-age are considered particularly useful for children under the age of one year. A higher percentage of preschool children suffer from a severe or moderate height-for-age deficiency than infants. However, since stunting is a cumulative process, older children have more time to show a significant degree of stunting.

3.2. Explanatory Variables

The definition of all variables and their descriptive statistics (means and standard deviations) are presented in table 3.

3.3. Wage Rates and Full Income

Monthly salary (in U.S. dollars) earned by individuals participating in the labor force was added to any payment in-kind received by them per month (transformed into dollars), and divided by the number of hours they worked per month to get the individual's hourly wage rates.

The wage rate estimation was done separately for men and women from age 16 up to 72. Some 86.7% of the men and 33.0% of the women had earnings from labor force employment. Therefore, a value of time for those that were not employed had to be estimated. Heckman's procedure was applied to estimate the wage rates.[11] First a probit equation was estimated for the sample of 6,633 women from age 16 up to 72. The dependent variable takes the value one if the woman had earnings from employment (2,187 of them) and 0 otherwise (4,446 of them). The same procedure was employed for the 6,083 men, where 5,273 had earnings from employment. Only the results for women will be shown here.

The variables assumed to affect the individual's decision on participating in the labor force are age in years (AGE), age squared (AGE2), education in years (EDUCATION), education squared (EDUCATION2), race (WHITE, BLACK, PARDA and ASIAN, which is omitted), sector (URBAN and RURAL, which is omitted), the relation of the individual in the household (HEAD, WIFE, DAUGHTER, RELATIVE, which is omitted and OTHER), non-labor income (NLINCOME, which is the sum of rents, pensions, alimony and others), the number of children less than 6 years old (NUMBCHILD) and region (CSES, which includes the Central, Southeastern and Southern regions, and NORTHEAST, which is omitted).[12]

The regions were divided into only two groups because the differences between the Central, Southeastern and Southern regions were not significant in terms of earnings. However, there were substantial differences between these regions and the Northeast, which is a poor area in Brazil. Also, the estimated wage rate of the man, who was the head of the household (WAGEHEAD) was assumed to affect the choice of the woman between working outside the house or not. However, the wage of the woman is not assumed to affect the man's employment decision.[13]

The coefficients in table 4 are highly significant and have the expected signs. The results indicate a parabolic relation for age, peaking at age 40. Education had the expected positive coefficient indicating that more years of schooling increase the probability of being employed. The quadratic term suggests that as years of school increase, the labor opportunities increase more than proportional to the increase in education.

The effect of the number of children less than 6 years old (NUMBCHILD) is negative, as expected, and highly significant. Women with young children at home are likely to have higher reservation wages, and therefore lower labor force participation rates. Also, the woman head of the household or the daughter are more likely to be employed than the wife of the male head. Urban areas are more developed than the rural sector and therefore offer more job opportunities. Finally, women are less likely to be employed the higher is non-labor income.

On the basis of the coefficients of the probit equation given in table 4, the inverse of the Mill's ratio (LAMBDA) was calculated and used as a variable in the wage equation. The results of the wage equation estimated by OLS for women participating in the labor force, using the natural logarithm of the hourly wage as the dependent variable, are given in table 5. The coefficient of determination (R^2) is very high for a wage equation estimated with cross sectional data.[14] The standard errors and t-statistics presented were recalculated using the White covariance matrix estimator that is consistent in the presence of heteroskedasticity.[15]

The coefficients from the wage equation are also highly significant and have the expected signs. The AGE coefficient is positive and the AGE2 parameter is negative showing that earnings follow a parabolic curve, peaking at about age 45. The results also indicate that individuals with higher education, living in more developed regions and in the urban sector receive higher wages. The inverse Mill's ratio variable (LAMBDA), obtained from the probit equation, is statistically significant, which means that its inclusion was necessary to avoid sample selection bias.

These coefficients were used to derive an estimated wage rate for each woman, age 16-71, whether she was employed or unemployed in the labor force. A similar procedure was used to estimate the wage rate for each man, age 16-71. The full income variable was calculated by multiplying the estimated wage rates for each household member, age 16-71, by 720 hours (24 hours a day times 30 days a month) and then adding any non-labor income. Full income is independent of time allocation decisions, and hence is exogenous. It represents the total economic resources available to the household.

4. EMPIRICAL ANALYSIS

4.1. Preschool Children's Health Demand Equations

The reduced-form health demand equations for children from 2-5 years old are presented in table 6. The Z-scores of height-for-age, weight-for-height and weight-for-age were used as dependent variables. In addition, a demand equation for height-for-age is presented in which the mother's literacy was interacted with the infrastructure variables. The White covariance matrix was estimated assuming that the errors were heteroskedastic. The standard errors found were similar to the ones estimated assuming a constant variance. Therefore, it was concluded heteroskedasticity was not a problem and the t-statistics obtained from the standard errors estimated assuming homoskedasticity are reported.

In addition to the father's and mother's Z-scores of height-for-age reflecting genetic endowments, these variables also capture investments in the parents' human capital and health.[16] It is important to standardize the parents' heights, since there are mothers and fathers who were adolescents. The coefficients estimated for the variables, ZHAMOT and ZHAFAT, were positive and highly significant on child height-for-age and weight-for-age, but on weight-for-height were insignificant.

The age of the child was represented by dummy variables. The KIDAGE3 variable takes the value one if the child is 3 years old, KIDAGE4 represents 4 year old children and KIDAGE5 5 year olds. The signs of the estimated coefficients for these variables are significant and negative in the height-for-age equation, but positive in the weight-for-height equation. The greatest prevalence of wasting (weight-for-height) occurs in early ages, when dietary deficiencies are common and diarrheal diseases more frequent. This explains the positive coefficients observed in column 2 for the variables KIDAGE. On the other hand, the prevalence of stunting (height-for-age) increases over time up to the age of 36 months and then shows a tendency to level off, which explains the negative coefficients of KIDAGE variables in the first column of table 6.[17]

The gender variable MALE was introduced because it has been observed in certain societies, such as in South Asia, that there is a strong preference towards boys in the intrahousehold allocation of resources. However, the gender effect was not significant in this study, indicating that Brazil has a more equitable allocation by gender than some societies.[18]

Differences in race did not have any impact on the child's height or weight. Most of the sample is composed of whites and "pardos" with a small percentage of blacks and Asians. The ethnic differences in Brazil are very large, but the effects on child height and weight are probably captured by other factors including the parents' Z-score variables.

Mothers older than 21 years (MOTAGE21) have an important positive effect on child height. However, the age of the father (FATAGE21) was insignificant. Older mothers presumably have more experience in child care and there are more household resources.[19] As expected, the coefficients of the dummy variables SEAST, SOUTH and CENTRAL regions were positive. The dummy variable representing the poor Northeastern region of Brazil was omitted.

A positive coefficient was expected for the urban sector variable. However, the coefficient is negative and highly significant. Income and infrastructure were included in the regression, and hence held constant. Urban areas are usually more polluted and densely populated which causes diseases to be spread easily and quickly. In addition, since prices are omitted variables, it is likely that the urban variable has captured their effect.[20]

The education of the parents was represented by four binary variables: if the fathers (FATLITER) or mothers (MOTLITER) were literate by the time of the survey, and if they had 5 or more years of school, i.e., (EDUFAT5) and (EDUMOT5) respectively for father and mother. The impact of parents being literate on the height of children was generally positive and significant. However, the variables representing the parents' years of schooling are not very relevant for the child's health status. Mother's schooling had a significant impact on weight-for-age (at the 10% level), whereas father's schooling was not significant. Some recent studies argue that the impact of education may be overestimated because of unobserved personal endowments of the parents.[21] However, in these results parental heights partially control for family background.[22]

The binary variables representing household-community infrastructure were set equal to one if the child's household had piped water or PLUMBING, a SEWERAGE system, ELECTRICITY and pavement in the street (STRPAVEM). The infrastructure coefficients were positive and significant in the height-for-age equation, as was observed in the earlier Thomas and Strauss study.[23] These investments improve health inputs (such as water), and are related to the overall healthiness of the environment.

When interaction terms between mother's literacy and infrastructure were introduced into the health demand equation, the coefficients of plumbing x literacy and sewerage x literacy were significant (see table 6, column 4). The signs were both negative, indicating that mother's education is a substitute for household infrastructure. Therefore, children of less educated mothers will benefit more from improvements in piped water and sewerage systems in Brazil, while more educated mothers have a greater ability to protect their children, if household infrastructure is deficient.[24]

The logarithm of per capita full income was highly significant and positive in all the equations. Although full income is an exogenous variable derived from a theoretical model, it has limited usefulness for policy recommendations. Therefore, non-labor income, non-mother income and money income were employed as other measures of household income. Money income includes the earnings from all the members of the household that were participating in the labor market in addition to non-labor income. Since this variable is endogenous, reflecting time allocation decisions, it was decided to also use money income excluding the mother's earnings (non-mother income), assuming that primarily the mother is involved in child care activities.[25] Non-labor income is exogenous. However, 67% of the observations in the sample had zero values. All these income variables' coefficients were positive and highly significant.

The coefficients of the mother's and father's estimated wage rates are negative, with one exception, and both are significant in the height-for-age equation.[26] As the wage increases, the relative cost of more time-intensive commodities rise. Child care is a time-intensive activity and is positively correlated with child health. However, this does not mean that an increase in wage rates has an overall impact on child health which is detrimental. In addition to the negative direct effect, there is an indirect effect through the income variable.

A simple simulation was performed using the first equation in table 6, assuming all variables other than mother's wage and full income remain at their mean values. The direct effect of a one standard deviation increase in the logarithm of the mother's wage (approximately a 52% change) causes a decrease in the child's height-for-age Z-score of -.07. In addition though, the mother accounts for 22% of the average household's full income. Given the positive coefficient, the child's Z-score would increase by .22 in response to the 11% rise in full income due to the mother's wage increase. The total net effect would be an improvement in the child's Z-score of .15, a 21% increase from the initial mean value of -.70 to -.55.

4.2. Preschool Children's Health Production Functions

The preschoolers' health production functions estimated by 2SLS and OLS are presented in table 7. The results were very similar, both in the significance levels and magnitudes of the coefficients. The dependent variable is the child's Z-score of height-for-age.

The endogenous variables assumed to affect the production of child health were: Filter, which takes the value one if there is a filter to purify the water in the household and zero otherwise. This variable is assumed to improve the quality of the water and consequently the health of the child.[27] The presence of a toilet is another choice variable assumed to improve the child's health due to an improvement in hygienic conditions, and a decrease in the sources of infectious diseases. Similarly, the presence of a refrigerator in the household is expected to increase health. A refrigerator better preserves food and reduces foodborne pathogens. It is considered a "form of capital equipment in household production".[28]

Milk, which is an important food for children, is also a dichotomous variable. The number of hours a mother works in the market sector is the only continuous variable. As the mother increases her time in the labor force, the time available for household activities, such as child care, decreases, which would result in a negative effect on the production of child health. The last two endogenous variables are related to children's participation in government programs, in terms of receiving food and health care.[29]

The exogenous variables included were: gender, race and age of the child, to control for biological and genetic differences. To control for unobserved genetic endowments, the Z-scores of height-for-age for the father and mother of the child were also included. Finally, the mother's number of years in school was used as a measure of production efficiency. It is expected that a more educated woman will be more efficient with respect to the child's health production.

As expected, the variables representing presence of a filter, toilet and refrigerator in the household as well as whether the child consumed milk, were all highly significant and had a positive effect on the child's health. The coefficient for the number of hours worked by the mother was negative, although not significant. The food and health program participation variables had a negative impact on child health. These can be explained by the fact that the small group participating in these programs was poor and perhaps already sick. The mother's education was highly significant and had a positive effect on the child's health production, as did the heights of the parents.

4.3. Infants' Health Demand Equations

The reduced-form health demand equations for infants are presented in table 8.[30] By contrast to the results obtained for the preschool children, the household infrastructure variables did not significantly affect the infant's health. Older children are much more in contact with the environment which these factors affect than infants.

The infant's age is represented by a dummy variable which takes the value of one if the infant is six months old or less (INFAGE6). The coefficients were positive and highly significant in all the equations of table 8. A large percentage of infants are breast-fed during the first six months, which improves their nutrition and decreases the occurrence of infectious diseases. The mother's and father's Z-scores of height-for-age were positive and highly significant in the height-for-age and weight-for-age equations. However, the coefficients were not significant at the 10% level in the weight-for-height equation. The mother's education had a positive and significant impact on height-for-age and weight-for-age. The effect of full income was positive and significant at least at the 10% level in two of the equations.

The estimated wage rates for the infant's mother and father had a negative effect on the infant's health. However, only the mother's wage in the weight-for-age equation was significant. The negative sign was expected and confirms the hypothesis that time-intensive activities, such as infant care and breast-feeding, will decrease as the opportunity cost of time increases. In this case, a one standard deviation increase in the logarithm of the mother's wage was simulated using the weight-for-age equation since it has the only statistically significant wage effect. The direct wage effect reduces the child's Z-score by -.16, whereas the indirect impact through full income increases it by .11, for a total net change of -.05, from an initial average Z-score of -.05 to -.10. Infants are more time-intensive than older children, particularly for the mother, so here the negative wage effect dominates the positive full income effect.

4.4. Infants' Health Production Functions

Linear and Cobb-Douglas health production functions for infants were estimated by OLS and 2SLS and are presented in table 9. More complex functional forms, such as Leontief and Translog, were also tried. However, the results showed a statistical rejection of those forms in favor of the restrictive Cobb-Douglas specification. The presence of a filter in the household to purify the water (FILTER), the number of months a mother breast-fed the child (BREASTFD), if she drank alcoholic beverages (ALCOHOL), the number of cigarettes she smoked per day (SMOKE), and the number of hours spent in the labor market (HOURWORK) are inputs assumed to affect the infant's health production.

The results of the production functions indicate that the consumption of alcohol and cigarettes by the mother has a negative effect on infant health, as was expected. However, except for SMOKE in the Cobb-Douglas specification, all others were not statistically significant. The use of cigarettes negatively affects the health of the mother, and consequently the infant's health, plus the exhaled smoke may affect the baby.[31]

The presence of a water filter had a positive impact and was robust to estimation technique and functional form. Filtering improves the quality of the drinking water. Its presence may also be correlated with other household capital and infrastructure that positively affect health.

The number of hours a mother works in the job market has a negative effect on the infant's health in all four equations. However, the coefficient is significant only in the linear specification estimated by 2SLS. When the mother works, household income increases. However, the time allocated to child care and breast-feeding decreases, since they are time-intensive activities.[32]

It would not, however, be correct to conclude that mothers should not participate in the job market when a young child is present. Improvements in the quality and availability of child care centers or other substitutes for the mother's care are needed, though. Moreover, maternal leave should be available to mothers in the first months of a child's life, during which they would be able to breast-feed the infant regularly and provide better care.[33]

The relation between breast-feeding and the child's health is observed to be non-linear. A variable breast-fed squared (BREASTFD2), beside the breast-fed variable (BREASTFD), was introduced. The coefficients are significant and robust to functional form. The positive effect of breast-feeding peaks between ages three and six months (columns 1 and 2 of table 9).

Medical studies show that the greatest benefits of breast-feeding occur during the first six months of the infant's life, when it is the best source of nutrition, increases the child's immunity, and has newly emphasized psychological effects. As the child gets older, his/her nutritional needs increase, and cannot be met by the exclusive consumption of breast milk, requiring supplemental foods.

The variable for the age of the infant was dropped from the equations estimated by 2SLS because of high collinearity observed with breast-feeding. This happens because the variable age, in the breast-feeding reduced-form equation, explains a large portion of the variation in the length of breast-feeding.

In contrast to our initial expectation, the variable representing MALE had a negative impact on health. Female infants may be stronger than male infants. The male coefficient in the previous three tables was not significant, indicating an absence of gender discrimination. The coefficient of the variable BLACK was positive and highly significant, when it was expected to be negative reflecting any racial discrimination. One could argue that black infants are genetically stronger, although the number of black infants in the sample is so small (only 4%), that it is probably the case that the sample was not really representative of the racial differences.

The mother's education (EDUMOT), which affects efficiency in producing children's health, had a highly significant, positive and robust effect on the infant's health status. Improvements in infant health can be indirectly obtained by improving the educational level of the mothers, although the caveats discussed earlier apply. Education increases the efficient use of inputs that positively affect the production of infants' health. Finally, both the mother's and father's Z-scores of height-for-age (ZHAMOT and ZHAFAT) were important determinants of the infant's health.

5. CONCLUSIONS

This study exploits the recent 1989 Brazilian National Health and Nutrition Survey to extend our understanding of the factors affecting child health status, as reflected in anthropometric measures of heights and weights. The economic theory of the household provides a unified framework for the analysis. Both reduced-form demand equations and structural production functions were estimated. Each serves a different and useful purpose. Particular care was given to estimation issues, especially the endogeneity of some explanatory variables and the impact of unobserved genetic and parental endowments. The empirical results have important implications for developing effective policies and programs to improve the health of children in Brazil and elsewhere. A key finding relates to the role of human capital and infrastructure investments.

Due to the richness of the data, this analysis was able to incorporate estimated wage rates for the parents as a measure of the value of their time, and full income, which reflects the total resources available to the household. Both concepts can be traced back to Gary Becker's original household model.[34] An increase in the mother's or father's wage rate has two distinct effects on the child's health. With only one exception in all the equations, the direct impacts of the wage variables on child height and weight are negative. The shadow price of time-intensive activities, such as child care, goes up as the value of time rises. However, an increase in their wages would also increase the household's full income which has a positive impact on child health. A simple simulation was conducted to judge the relative strength of the two effects. For preschoolers the positive income effect dominates. For infants, who are more time-intensive, the negative direct effect of the mother's wage is stronger.

In terms of other significant factors in the demand relations, household infrastructure has a strong positive impact on the health of preschoolers. They are healthier when piped water, sewers, electricity, and paved streets are present. Urbanization has a negative effect, though. With infrastructure and other factors held constant, it is probably the adverse implications of greater population density and pollution that are being captured. Both preschoolers and infants are worse off in the Northeastern region, which should not be surprising since it is Brazil's poorest area. However, this result occurs in addition to the effect of factors included in the demand equations.

Father's and mother's heights are included in both the demand and production functions. They serve as proxies for unobserved genetic endowment, as well as parental endowments reflecting family background and human capital. Taller parents have healthier children, as measured by their heights and weights. An important intergenerational effect exists. An improvement in the health of the current generation of children, who then grow taller, would have a positive impact on the next generation, and so on.

The children of better educated parents are also healthier. Variables for both parents' literacy and years of schooling were included in the demand relations. Mothers who can read and write have a particularly beneficial impact on their children's health. In fact, literate mothers can help protect their children from the absence of household infrastructure. Literacy acts as a substitute for infrastructure. Mother's education is also included as an input in the production relations and has a significant positive impact for both preschoolers and infants. As the recent literature makes clear, the effect of education can be biased by a correlation with unobserved parental characteristics. Inclusion of the parents' heights should help alleviate this problem, though.

Based on the production function results, preschoolers are healthier when household capital in the form of water filters, refrigerators, and toilets are present. The consumption of milk is also clearly beneficial. Infants seem to benefit from mothers who do not smoke or drink alcohol and who work fewer hours outside the home. Breast-fed infants are healthier and the positive impact is stronger the younger is the baby. Although breast-feeding is a mother's private decision, government can encourage it through education programs, maternal work leave for the first several months after birth, and child care located at the place of employment so mothers could visit their infants to feed them during the work day.

Many of the factors affecting child health are either directly or indirectly related to investments in human capital or infrastructure. Most such investments are at least partially public goods with substantial externalities. The market will supply suboptimum amounts and government action is necessary. Many countries, including Brazil, underinvest in human capital and infrastructure. This is shortsighted because not only does child health, the focus of this study, suffer, but the long-run consequences include reduced productivity and economic growth.

ENDNOTES

1. United Nations, Administrative Committee on Coordination - Subcommittee on Nutrition, Second Report on the World Nutrition Situation, Vol. I, Geneva, October (1992):1.

2. J. Behrman and A. Deolalikar, "Health and Nutrition", Handbook of Development Economics, ed. Hollis Chenery and T. N. Srinivasan (New York: North Holland, 1 1988):631-711, provides an excellent review.

3. Amartya Sen, "The Economics of Life and Death," Scientific American (May 1993):40-47.

4. Gary Becker, "A Theory of the Allocation of Time," The Economic Journal 75 (1965):493-517, and G. Becker, A Treatise on the Family (Cambridge: Harvard University Press, 1981).

5. D. Thomas, J. Strauss, and M. H. Henriques, "Child Survival, Height for Age and Household Characteristics in Brazil," Journal of Development Economics 33 (1990):197-234; and D. Thomas and J. Strauss, "Prices, Infrastructure, Household Characteristics and Child Height," Journal of Development Economics 39 (1992):301-331.

6. See J. Behrman and A. Deolalikar, "Health and Nutrition."

7. It would be ideal to have the amount of time spent in child care. However, the data set available provides information only on the labor-market work time of individuals 10 years old or more.

8. See Thomas, Strauss and Henriques.

9. See Susan Horton, "Child Nutrition and Family Size: Results from the Philippines," mimeographed (Dept. of Economics,

University of Toronto, 1984).

10. World Health Organization Working Group, "Use and Interpretation of Anthropometric Indicators of Nutritional Status," *Bulletin of the World Health Organization* 64 (1986):929-941. Also, J. C. Waterlow, "The Presentation and Use of Height and Weight Data for Comparing the Nutritional Status of Groups of Children Under the Age of 10 Years," *Bulletin of the World Health Organization* 55 (1977):489-498.

11. See J. Heckman, "Shadow Prices, Market Wages, and Labor Supply," *Econometrica* 1 (1974):679-694; and J. Heckman, "Sample Selection Bias as a Specification Error," *Female Labor Supply: Theory and Estimation*, ed. James P. Smith (Princeton University Press, 1980).

12. Parda is a race defined as between black and white.

13. B. Senauer, D. Sahn, and H. Alderman, "The Effect of the Value of Time on Food Consumption Patterns in Developing Countries: Evidence from Sri Lanka," *American Journal of Agricultural Economics* 68 (1986):920-927.

14. Ibid.

15. H. White, "A Heteroskedasticity Consistent Covariance Matrix Estimator and a Direct Test for Heteroskedasticity," *Econometrica* 4 (1980):817-838.

16. See, for example, Thomas, Strauss, and Henriques, and Thomas and Strauss.

17. WHO Working Group.

18. J. Strauss, "Household, Communities, and Preschool Children's Nutrition Outcomes: Evidence from Rural Cote d'Ivoire," Economic Development and Cultural Change 38 (1990):235-261; and S. Horton, "Birth Order and Child Nutritional Status: Evidence from the Philippines," Economic Development and Cultural Change 36 (1988):341-354 also found the gender effect insignificant.

19. Horton, "Birth Order" found that mother's age had a significant positive impact on child's height-for-age, while Strauss concluded that the impact of the mother's age was insignificant.

20. Thomas and Strauss observed that food prices in the rural sector of Brazil were lower than in the urban sector.

21. J. Behrman and B. Wolfe, "How does Mother's Schooling Affect Family Health, Nutrition, Medical Care Usage, and Household Sanitation?" Journal of Econometrics 36 (1987):185-204. Also see J. R. Behrman, "Women's Schooling and Nonmarket Productivity: A Survey and Reappraisal," mimeographed (World Bank, Washington D.C. 1990).

22. See Thomas, Strauss, and Henriques, p. 211.

23. Thomas and Strauss showed that the per capita number of buildings with water, sewerage hookups and electricity connections was positively associated with the height of Brazilian children.

24. A. Barrera, "The Role of Maternal Schooling and its Interaction with Public Health Programs in Child Health Production," Journal of Development Economics 32 (1990):69-91, noticed that children of less educated mothers derived greater

health gains from an improvement in the cleanliness of the environment. Thomas and Strauss concluded that an increase in the prices of dairy products, sugar and fish negatively affected children's health, but in greater proportion when the mothers were illiterate, indicating that more educated mothers were able to better protect their children in the case of costly resources. However, they also observed that children whose mothers were better educated benefited more from the availability of sewerage and electricity.

25. See Thomas, Strauss, and Henriques.

26. There may be some concern that wages are endogenous and hence simultaneous equation bias could exist. Individuals' productivity and wage rates are affected by their consumption, of food and health inputs in particular. This problem is alleviated since the procedure used is akin to 2SLS in which the estimated wage is a function of exogenous instrumental variables.

27. M. Pitt and M. Rosenzweig, "Agricultural Prices, Food Consumption and the Health and Productivity of Indonesian Farmers," <u>Agricultural Household Models</u> ed. I. Singh, L. Squire and J. Strauss, (Baltimore: John Hopkin University Press,1986) included in an illness production function whether or not the household boiled their water, and found statistically significant results.

28. B. Wolfe and J. Behrman, "Determinants of Child Mortality Health, and Nutrition in a Developing Country," <u>Journal of Development Economics</u> 11 (1982):163-193, and B. Wolfe and J.

Behrman, "Is Income Overrated in Determining Adequate Nutrition?" Economic Development and Cultural Change 31 (1983):525-549.

29. Food program and health program variables were not used as explanatory variables in the equation estimated by 2SLS, because they had a large number of zero values, resulting in a column of zeros as estimates.

30. Initially, health demand and production functions were estimated for infants with ages ranging between 0 and 24 months. However, in this age range, the structural process of producing child health changes. Breast-feeding and child care are very important inputs in the first year of an infant's life but their importance decreases after that. Therefore, it was decided to focus the analysis on infants from 0 to 12 months old.

31. Yamada et al. "Nutrition and Infant Health in Japan," The Journal of Human Resources 24 (1989):725-736, concluded that cigarette and alcohol consumption had a strong and adverse effect on infants' health. M. Rosenzweig and T. P. Schultz, "Estimating a Household Production Function: Heterogeneity, the Demand for Health Inputs, and their Effects on Birth Weight," Journal of Political Economy 91 (1983):723-746 also found mothers smoking during pregnancy negatively affected the birth weight of the child.

32. S. Nerlove, "Women's Workload and Infant Feeding Practices: A Relationship with Demographic Implications," Ethnology (1974):207-214; and B. Popkin and F. Solon, "Income, Time, the Working Mother and Child Nutrition," Environmental Child Health (1976):156-166

also concluded that breast-feeding activities declined when mothers participated in the labor market. B. Popkin, "Time Allocation of the Mother and Child Nutrition," Ecology of Food and Nutrition 9 (1980):1-14, observed a negative association between the child's nutritional status and mother's market work status. These papers, however, used a dummy variable taking the value of one if the mother worked outside the household, and not the number of hours she is employed. Moreover, they considered the work status of the mother as an exogenous variable. An interesting work by F. Blau and A. Grossberg, "Maternal Labor Supply and Children's Cognitive Development, "The Review of Economics and Statistics 3 (1992):474-481, where the authors were very careful in terms of econometric issues, found that maternal employment during the first year of the children's life had a negative impact on their cognitive development.

33. A policy was enacted in Brazil in 1934 to allow mothers to receive their salaries, without having to work, 4 weeks before and 4 weeks after a child was born. In 1943 the duration of maternal leave increased to 6 weeks before and 6 weeks after, and in 1988 to 8 weeks before and 8 weeks after a child was born. How effectively this policy has been implemented is another question.

34. Becker, "A Theory of the Allocation of Time."

Table 1 - The Percent of Preschool Children by Z-score Categories for Height/Age, Weight/Height and Weight/Age.

	Z-score Intervals	Degree of Malnutr.	Total	Regions NE	SE	S	C	Sectors U	R
A. Height/Age									
	< -3	Severe	4.4	8.7	2.7	2.5	1.8	2.7	5.7
	[-3, -2)	Moderate	11.5	19.7	8.0	7.3	7.6	8.7	13.8
	[-2, -1)	Mild	23.9	29.7	21.8	19.2	22.2	20.3	26.7
	> -1	Normal	60.2	41.8	67.4	71.0	68.4	68.3	53.7
B. Weight/Height									
	< -3	Severe	0.3	0.4	0.3	0.1	0.3	0.2	0.3
	[-3, -2)	Moderate	1.0	1.2	0.8	0.7	1.3	0.6	1.3
	[-2, -1)	Mild	9.2	11.2	10.2	4.5	10.0	8.2	10.0
	> -1	Normal	89.5	87.2	88.7	94.8	88.5	90.9	88.4
C. Weight/Age									
	< -3	Severe	0.8	1.5	0.5	0.4	0.4	0.5	1.0
	[-3, -2)	Moderate	5.9	10.1	5.1	2.7	4.0	3.8	7.6
	[-2, -1)	Mild	24.0	33.7	20.4	16.0	21.5	19.1	27.9
	> -1	Normal	69.3	54.7	73.9	81.0	74.2	76.5	63.5

Table 2 - The Percent of Infants by Z-score Categories for Height/Age, Weight/Height and Weight/Age.

Z-score Intervals	Degree of Malnutr.	Total	Regions				Sectors	
			NE	SE	S	C	U	R
A. Height/Age								
< -3	Severe	3.8	6.0	2.4	3.9	2.1	3.0	4.5
[-3, -2)	Moderate	6.7	10.1	6.5	6.1	2.8	5.6	7.6
[-2, -1)	Mild	20.1	24.9	20.3	18.6	14.5	16.4	23.1
> -1	Normal	69.3	59.0	70.8	71.4	80.7	75.0	64.7
B. Weight/Height								
< -3	Severe	1.4	1.5	0.4	1.8	1.8	1.4	1.3
[-3, -2)	Moderate	1.8	1.5	2.8	1.1	1.8	1.8	1.7
[-2, -1)	Mild	7.8	9.1	6.3	5.5	9.6	7.9	7.7
> -1	Normal	89.1	87.9	90.5	91.6	86.8	88.9	89.2
C. Weight/Age								
< -3	Severe	1.8	3.5	0.0	0.7	2.1	0.5	2.8
[-3, -2)	Moderate	3.6	6.8	3.4	1.1	1.7	4.2	3.2
[-2, -1)	Mild	15.8	20.5	14.8	11.7	13.8	13.9	17.3
> -1	Normal	78.8	69.1	81.8	86.5	82.4	81.4	76.7

Table 3 - Description of the Variables, Means and Standard Deviations, for Infants and Preschool Children.

Variable	Definition	Infants Mean	Infants S.D.	Preschoolers Mean	Preschoolers S.D.
Endogenous					
ZHACHILD	child's Z-score height for age	-0.45	1.39	-0.70	1.35
ZWHCHILD	child's Z-score weight for height	0.34	1.22	0.11	0.99
ZWACHILD	child's Z-score weight for age	-0.05	1.28	-0.38	1.18
FILTER	=1 if the water is filtered	0.43	0.50	0.47	0.50
TOILET	=1 if there is toilet in the residence	0.48	0.50	0.47	0.50
REFRIG	=1 if there is refrigerator in the residence	0.43	0.50	0.47	0.50
MILK	=1 if child drinks milk	.	.	0.82	0.38
BREASTFD	the length a child is breast-fed in months	4.26	3.37	.	.
FDPROG	=1 if child participates in food programs	0.11	0.31	0.11	0.31
HTPROG	=1 if child participates in health programs	0.06	0.23	0.04	0.19
MOTWORK	=1 if mother is in labor market	0.21	0.41	0.31	0.46
SMOKE	cigarettes smoked by the mother per day	2.70	5.87	2.95	6.01
DRINK	=1 if mother drinks alcoholic beverages	0.14	0.35	0.14	0.34
Exogenous-Individual					
WHITE	=1 if child is white	0.49	0.50	0.47	0.50
BLACK	=1 if child is black	0.03	0.17	0.04	0.20
ASIAN	=1 if child is Asian	0.004	0.06	0.003	0.06
MALE	=1 if child is male	0.51	0.50	0.51	0.50
KIDAGE	age of the child in months	6.21	3.78	45.19	10.96
KIDAGE3	=1 if child is 3 years old	.	.	0.26	0.44
KIDAGE4	=1 if child is 4 years old	.	.	0.25	0.43
KIDAGE5	=1 if child is 5 years old	.	.	0.25	0.44
ZHAMOT	mother's Z-score height for age	-1.36	1.12	-1.38	1.07
ZHAFAT	father's Z-score height for age	-1.35	1.10	-1.35	1.09
AGEFAT	age of the father in years	31.87	8.79	35.39	8.52
FATAGE21	=1 if father is 21 or older	0.85	0.36	0.86	0.34
AGEMOT	age of the mother in years	26.69	6.55	30.46	6.85
MOTAGE21	=1 if mother is 21 or older	0.75	0.43	0.90	0.30
EDUFAT	father's number of years in school	3.98	3.89	3.77	3.94
FATLITER	=1 if father is literate	0.66	0.47	0.62	0.48
EDUFAT5	=1 if father has 5 years of education or more	0.29	0.45	0.24	0.43
EDUMOT	mother's number of years in school	4.38	3.81	4.19	3.91
MOTLITER	=1 if mother is literate	0.77	0.42	0.72	0.45
EDUMOT5	=1 if mother has 5 years of education or more	0.36	0.48	0.32	0.46
WAGEMOT	estimate of the mother's wage in dollars per hour	0.29	0.35	0.34	0.41
LWAGEMOT	logarithm of the WAGEMOT	-1.57	0.74	-1.43	0.75
WAGEFAT	estimate of the father's wage in dollars per hour	0.81	0.81	0.85	0.83
LWAGEFAT	logarithm of the WAGEFAT	-0.48	0.66	-0.43	0.65
FLINCPC	estimate of monthly full income per capita	197.21	218.14	192.33	211.30
LFLINCPC	logarithm of FULINCPC	4.90	0.82	4.88	0.83
MONINCPC	money income per capita	56.25	109.61	58.84	117.26
LMONINCPC	logarithm of MONINCPC	3.33	1.12	3.31	1.17
NMINCPC	nonmother income per capita	51.23	100.23	50.83	103.75
LNMINCPC	logarithm of NMINCPC	3.26	1.07	3.20	1.17
NLINCPC	non-labor income per capita	2.85	15.81	3.90	40.81
LNLINCPC	logarithm of NLINCPC	-1.32	1.70	-1.27	1.74
HHSIZE	number of people in a household	5.67	2.59	5.81	2.37
Exogenous-Area					
URBAN	=1 if child resides in urban areas	0.45	0.50	0.45	0.50
NEAST	=1 if child resides in Northeast region	0.33	0.47	0.32	0.47
SEAST	=1 if child resides in Southeast region	0.23	0.42	0.23	0.42
SOUTH	=1 if child resides in South region	0.22	0.41	0.22	0.41
CENTRAL	=1 if child resides in Central region	0.22	0.42	0.23	0.42
PLUMB	=1 if there is water installations in the residence	0.49	0.50	0.52	0.50
SEWERAGE	=1 if there is sewerage system in the residence	0.26	0.44	0.27	0.44
ELECTRIC	=1 if there is electricity in the residence	0.65	0.48	0.67	0.47
STRPAVEM	=1 if there is pavement in the street of residence	0.23	0.42	0.25	0.44

Table 4 - Results of the Probit Analysis on Labor Force Activity of Women, Ages 16-71.

Variable	Coefficient
Constant	-2.4987
	(-7.35) ***
AGE	0.1105
	(12.09) ***
AGE2	-0.0014
	(-11.47) ***
EDUCATION	0.0631
	(11.31) ***
EDUCATION2	0.000064
	(11.38) ***
NUMBCHILD	-0.0637
	(-2.78) ***
HEAD	0.5582
	(5.82) ***
WIFE	-0.3029
	(-4.38) ***
DAUGHTER	0.2950
	(3.87) ***
OTHER	1.4905
	(10.38) ***
CSES	0.0119
	(0.28)
WHITE	-0.2574
	(-0.87)
BLACK	-0.0575
	(-0.19)
PARDA	-0.1925
	(-0.65)
URBAN	0.3749
	(9.02) ***
NLINCOME	-0.00098
	(-2.24) **
WAGEHEAD	-0.0417
	(-1.05)

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.

Table 5 - Results of the Wage Equation for Women with Labor Force Earnings, Ages 16-71.

Variable	Coefficient
Constant	-4.0448
	(-10.59) ***
AGE	0.0856
	(7.87) ***
AGE2	-0.00094
	(-5.86) ***
EDUCATION	0.0845
	(5.82) ***
EDUCATION2	0.0042
	(4.35) ***
URBAN	0.2906
	(6.25) ***
CSES	0.4539
	(10.78) ***
WHITE	0.0298
	(0.09)
BLACK	-0.1332
	(-0.40)
PARDA	-0.0257
	(-0.08)
LAMBDA	0.3586
	(5.32) ***
R^2	0.46
Wald test	1696.4 ***

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.

Table 6 - Preschool Children's Health Demand Equations.

	Z-Scores			
Variables	Height/Age	Weight/Height	Weight/Age	Height/Age (with interactions)
Constant	-2.663	-0.724	-2.150	-2.622
	(-6.26) ***	(-1.94) *	(-5.51) ***	(-6.15) ***
PLUMB	0.177	0.060	0.141	0.325
	(3.55) ***	(1.37)	(3.08) ***	(3.10) ***
SEWERAGE	0.139	0.079	0.145	0.419
	(2.58) ***	(1.67) *	(2.92) ***	(2.65) ***
ELECTRIC	0.200	0.070	0.166	0.102
	(3.88) ***	(1.67) *	(3.50) ***	(1.15)
STRPAVEM	0.096	-0.052	0.009	0.202
	(1.69) *	(-1.05)	(0.17)	(1.31)
URBAN	-0.227	-0.063	-0.180	-0.227
	(-4.11) ***	(-1.30)	(-3.55) ***	(-4.10) ***
SOUTH	0.012	0.228	0.171	0.003
	(0.19)	(4.21) ***	(3.01) ***	(0.05)
SEAST	0.122	0.078	0.131	0.114
	(2.05) **	(1.50)	(2.39) **	(1.91) *
CENTRAL	0.265	0.017	0.154	0.251
	(4.68) ***	(0.337)	(2.97) ***	(4.41) ***
ZHAMOT	0.318	0.018	0.199	0.318
	(17.54) ***	(1.12)	(11.97) ***	(17.58) ***
ZHAFAT	0.270	-0.008	0.150	0.271
	(15.23) ***	(-0.52)	(9.23) ***	(15.30) ***
MOTAGE21	0.198	0.045	0.153	0.200
	(2.55) **	(0.66)	(2.15) **	(2.57) **
FATAGE21	0.098	-0.280	-0.215	0.083
	(0.47)	(-1.53)	(-1.12)	(0.40)
FATLITER	0.100	-0.020	0.043	0.094
	(2.02) **	(-0.46)	(0.95)	(1.91) *
EDUFAT5	-0.051	0.001	-0.029	-0.048
	(-0.83)	(0.02)	(-0.52)	(-0.78)
MOTLITER	0.180	-0.034	0.076	0.219
	(3.60) ***	(-0.79)	(1.66) *	(3.38) ***
EDUMOT5	0.068	0.077	0.090	0.082
	(1.17)	(1.52)	(1.70) *	(1.42)
KIDAGE3	-0.271	0.166	-0.008	-0.274
	(-5.39) ***	(3.77) ***	(-0.18)	(-5.45) ***
KIDAGE4	-0.296	0.138	-0.007	-0.293
	(-5.79) ***	(3.07) ***	(-0.16)	(-5.72) ***
KIDAGE5	-0.319	0.151	0.019	-0.316
	(-6.24) ***	(3.37) ***	(0.41)	(-6.17) ***

Table 6 - continued

	Z-Scores			
Variables	Height/Age	Weight/Height	Weight/Age	Height/Age interaction
WHITE	0.051	0.040	0.068	0.054
	(1.17)	(1.06)	(1.72) *	(1.24)
BLACK	0.115	-0.114	0.001	0.111
	(1.18)	(-1.34)	(0.01)	(1.15)
ASIAN	0.338	-0.280	-0.029	0.356
	(1.22)	(-1.15)	(-0.11)	(1.28)
MALE	0.005	-0.034	-0.008	0.005
	(0.14)	(-1.10)	(-0.25)	(0.15)
LFLINCPC	0.410	0.171	0.370	0.406
	(6.86) ***	(3.26) ***	(6.74) ***	(6.78) ***
LWAGEMOT	-0.098	0.011	-0.042	-0.092
	(-2.12) **	(0.26)	(-0.99)	(-1.97) **
LWAGEFAT	-0.118	-0.055	-0.110	-0.108
	(-1.76) *	(-0.93)	(-1.77) *	(-1.60)
<u>Interactions</u>				
PLUMBxLITER	.	.	.	-0.195
				(-1.66) *
SEWERxLITER	.	.	.	-0.311
				(-1.85) *
ELECTxLITER	.	.	.	0.117
				(1.13)
STRPAxLITER	.	.	.	-0.118
				(-0.72)
R^2	0.35	0.06	0.26	0.35
F Statistic	80.60 ***	8.73 ***	51.59 ***	70.36 ***
Observations	3914	3908	3908	3914

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.

Table 7 - Preschool Children's Health Production Functions.

	ZHACHILD	
Variables	2SLS	OLS
Constant	-0.399 (-2.65) ***	-0.336 (-4.72) ***
FILTER[a]	0.215 (4.92) ***	0.219 (5.93) ***
REFRIG[a]	0.274 (4.24) ***	0.416 (8.58) ***
DRMILK[a]	0.379 (2.71) ***	0.318 (6.54) ***
TOILET[a]	0.152 (2.40) **	0.197 (4.17) ***
FDPROG	.	-0.159 (-2.32) **
HTPROG	.	-0.164 (-1.54)
HOURWORK[a]	-0.002 (-0.99)	-0.001 (-1.19)
MALE	-0.011 (-0.29)	-0.011 (-0.33)
BLACK	0.131 (1.36)	0.108 (1.16)
KIDAGE3	-0.268 (-5.26) ***	-0.269 (-5.40) ***
KIDAGE4	-0.301 (-5.78) ***	-0.319 (-6.27) ***
KIDAGE5	-0.298 (-5.73) ***	-0.326 (-6.45) ***
ZHAMOT	0.338 (18.60) ***	0.317 (17.79) ***
ZHAFAT	0.289 (16.27) ***	0.278 (16.04) ***
EDUMOT	0.038 (5.65) ***	0.023 (3.98) ***
R^2	0.33	0.35
F Statistic	145.86 ***	141.31 ***
Observations	3914	3919

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.
[a] endogenous variables.

Table 8 - Infants' Health Demand Equations.

Variables	Z-Scores Height/Age		Weight/Height		Weight/Age	
Constant	-2.036		-1.333		-2.501	
	(-2.55)	**	(-1.72)	*	(-3.39)	***
PLUMB	0.111		-0.019		0.107	
	(1.01)		(-0.18)		(1.05)	
SEWERAGE	0.001		-0.010		-0.003	
	(0.01)		(-0.10)		(-0.03)	
ELECTRIC	0.125		0.149		0.150	
	(1.12)		(1.37)		(1.45)	
STRPAVEM	0.063		0.100		0.129	
	(0.52)		(0.85)		(1.15)	
URBAN	-0.134		-0.071		-0.140	
	(-1.15)		(-0.63)		(-1.30)	
SOUTH	0.202		0.371		0.447	
	(1.49)		(2.84)	***	(3.57)	***
SEAST	0.144		0.261		0.328	
	(1.11)		(2.07)	**	(2.72)	***
CENTRAL	0.418		-0.018		0.263	
	(3.29)	***	(-0.15)		(2.24)	**
ZHAMOT	0.209		-0.007		0.174	
	(5.57)	***	(-0.20)		(5.00)	***
ZHAFAT	0.224		-0.058		0.122	
	(5.82)	***	(-1.56)		(3.42)	***
MOTAGE21	0.116		0.159		0.276	
	(1.02)		(1.45)		(2.64)	***
FATAGE21	0.237		0.100		0.235	
	(1.27)		(0.56)		(1.37)	
FATLITER	-0.078		0.107		0.070	
	(-0.72)		(1.01)		(0.68)	
EDUFAT5	-0.251		0.230		0.040	
	(-1.95)	*	(1.85)	*	(0.34)	
MOTLITER	0.297		0.062		0.221	
	(2.60)	***	(0.56)		(2.08)	**
EDUMOT5	0.315		-0.028		0.204	
	(2.50)	**	(-0.23)		(1.75)	*
INFAGE6	0.243		0.175		0.431	
	(3.17)	***	(2.35)	**	(6.07)	***
WHITE	-0.098		-0.039		-0.095	
	(-1.06)		(-0.44)		(-1.10)	

Table 8 - continued

	Z-Scores		
Variables	Height/Age	Weight/Height	Weight/Age
BLACK	0.640	-0.436	0.102
	(2.73) ***	(-1.93) *	(0.48)
ASIAN	0.716	0.935	1.339
	(1.14)	(1.55)	(2.29) **
MALE	-0.109	-0.053	-0.063
	(-1.42)	(-0.71)	(-0.88)
LFLINCPC	0.221	0.130	0.244
	(1.78) *	(1.08)	(2.12) **
LWAGEMOT	-0.157	-0.138	-0.212
	(-1.46)	(-1.32)	(-2.13) **
LWAGEFAT	-0.010	-0.159	-0.144
	(-0.07)	(-1.16)	(-1.10)
R^2	0.20	0.04	0.19
F Statistic	10.73 ***	1.93 ***	10.39 ***
Observations	1073	1048	1085

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.

Table 9 - Infants' Health Production Functions.

	Linear				Cobb-Douglas			
	2SLS		OLS		2SLS		OLS	
Constant	-0.095		0.040		1.343		1.359	
	(-0.54)		(0.28)		(14.15)	***	(14.37)	***
ALCOHOL[a]	-0.616		-0.051		-0.076		-0.002	
	(-0.81)		(-0.44)		(-0.92)		(-0.15)	
SMOKE[a]	-0.033		-0.003		-0.025		-0.004	
	(-0.89)		(-0.50)		(-1.80)	*	(-1.88)	*
HOURWORK[a]	-0.013		-0.002		-0.004		-0.001	
	(-2.59)	***	(-0.86)		(-1.40)		(-0.57)	
BREASTFD[a]	0.184		0.095		0.036		0.007	
	(2.80)	***	(2.15)	**	(2.39)	**	(1.02)	
BREASTFD2[a]	-0.027		-0.008		-0.025		-0.004	
	(-3.56)	***	(-2.26)	**	(-3.53)	***	(-1.92)	*
FILTER[a]	0.143		0.147		0.022		0.019	
	(1.67)	*	(1.78)	*	(2.25)	**	(2.16)	**
MALE	-0.130		-0.135		-0.013		-0.014	
	(-1.69)	*	(1.72)	*	(-1.53)		(-1.65)	*
BLACK	0.716		0.630		0.065		0.062	
	(2.96)	***	(2.73)	***	(2.44)	**	(2.47)	**
KIDAGE	.		-0.032		.		-0.008	
	.		(-2.30)	**	.		(-1.28)	
ZHAMOT	0.204		0.214		0.196		0.213	
	(5.43)	***	(5.60)	***	(5.44)	***	(5.96)	***
ZHAFAT	0.234		0.231		0.206		0.201	
	(6.23)	***	(5.96)	***	(5.78)	***	(5.62)	***
EDUMOT	0.060		0.046		0.011		0.012	
	(4.29)	***	(3.93)	***	(3.50)	***	(4.09)	***
R^2	0.19		0.17		0.19		0.17	
F Statistic	22.71	***	16.63	***	23.22	***	16.65	***
Observations	1073		1005		1073		1005	

t-statistics are given in parentheses below the coefficients.
* denotes significance at the 10% level.
** denotes significance at the 5% level.
*** denotes significance at the 1% level.
[a] endogenous variables.