Staff Papers Series

Staff Paper P88-33

September 1988

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by

Benjamin Senauer
University of Minnesota

Marito Garcia
International Food Policy Research Institute

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

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*The authors wish to thank Henry Hwang at the University of Minnesota and Elizabeth Jacinto at the International Food Policy Research Institute for their assistance with the computer work.

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INTRODUCTION

Although nutritional inadequacies can affect all segments of the population, the most serious malnutrition problems typically are found among certain groups within the population of poor in developing countries. Preschool children, along with infants and pregnant and lactating women, are usually considered the groups at greatest nutritional risk.[1] Malnutrition affects the rate of morbidity and mortality among the young and also poses a threat to their physical and mental development. Preschool children account for a disproportionately large share of the deaths in most developing countries. Nutritional deprivation is either directly or indirectly associated with most of those deaths. The very young are less able to cope physiologically with nutritional deficiencies than older children and adults. In addition, children who suffer a loss of growth due to early nutritional deprivation have only a limited capacity to overcome the resulting stunting. For these reasons, there is particular interest in the determinants of the nutrient intake and nutritional status of preschool children in low income, developing countries.[2]

The data used in this analysis are from household surveys carried out in three rural provinces of the Philippines in 1983-84 by the Philippine National Nutrition Council, the Ministry of Agriculture, and the International Food Policy Research Institute. The surveys were conducted with the specific purpose of evaluating a pilot food price subsidy, which subsidized the price of rice and cooking oil in selected villages. The pilot food subsidy was purposely tested in areas with high rates of poverty and malnutrition. The data were collected in four separate survey rounds spaced across the 18 month period from May 1983 to October 1984. The same, approximately 800, households were surveyed in each survey round.[3] The data are, therefore, longitudinal with both time-series and cross-sectional variation.

The surveys collected information on household size and composition, expenditures and food consumption, earnings by source and individual, and time allocation of the husband and wife. Anthropometric data, weight and height, were obtained for all children less than seven years old in the surveyed households. Individual food consumption data for a 24-hour period were obtained for all household members in a subsample of 140 households in each of the four survey rounds. This data set allowed the introduction of some unique features in the analysis.

This study estimates reduced form equations for the food consumption and nutritional status of preschool children (13-83 months of age). The food consumption indicators used are the child's calorie intake and calorie adequacy ratio.[4] The anthropometric measurements of nutritional status utilized are the child's z-score of height for age and weight for height, which are indicators of the child's long-run or chronic nutritional status, termed stunting, and the child's short-run or current nutritional status, termed wasting, respectively. Two estimating models are utilized to take full advantage of the longitudinal data. In the first model, the observations for a given child across the various survey rounds were averaged and regressions run with the variable means. This model examines between-child variation and allows an analysis of time-invariant determinants. A fixed effects model was also estimated, based on the differences in a particular survey round from the child-specific means for each variable. This model analyzes the within-child variation and eliminates the effect of any unmeasured or unobservable, time-invariant factor specific to a child, such as genetic endowment. With the available data, certain unique explanatory variables could also be introduced into the analysis, including the child's birth order, the mother's and father's value of time (estimated wage), the price of two major food staples, the food price subsidy program, and two nutrition education programs.

ANALYTICAL FRAMEWORK

This section first outlines the derivation of reduced form equations for calorie consumption and nutritional status from a theoretical model of the household. The two estimating models applied to the longitudinal data are then discussed.

Theoretical Model

As argued by Strauss, many of the previous studies of child nutrition failed to distinguish between exogenous variables and endogenous household choice variables.[5] They ignored the simultaneity of many of the factors which affect nutrition outcomes, such as food consumption and illness. Even a household's earned income should be considered endogenous since it reflects time allocation decisions. Many studies estimated some combination of a structural production function and reduced form equation using ordinary least squares, which produces biased estimates.

The reduced form equations for child food consumption and nutritional status can be derived from a multiperson household model which encompasses household production and consumption decisions. The genesis of such a New Household Economics models can be traced back to Becker.[6] The approach presented here draws directly on the model developed by Pitt and Rosenzweig.[7] A household behaves as if maximizing a joint utility function:

$$U = U(H,L,F,Z) \tag{1}$$

Given n family members, H,L,F and Z are 1 x n vectors of the health status H^i, leisure L^i, food consumption F^i, and non-food consumption Z^i for every family member i. In this study, the health indicator of interest is nutritional status, and specifically anthropometric measurements (weight and height). The particular indicator of food consumption utilized is calorie intake and the calorie adequacy ratio. Because good health is desirable in itself and food is consumed for reasons other than its nutrient value, both appear directly in the utility function.

Health (nutritional status) is a household produced commodity. The health production function for the i^{th} child is:

$$H^i = H(F^i, T^i, C^i, D^i, G^i, U^i) \tag{2}$$

where H^i is the health (nutritional status) of the i^{th} child as indicated by weight and height measurements, F^i is that child's food consumption as indicated by calorie intake, T^i is a vector of the child care time inputs of other family members which affect the i^{th} child's health, C^i is a vector of the i^{th} child's observable characteristics, such as age and gender, D^i is a vector of the observed personal characteristics of the child's parents, such as their age and education, G^i is a vector of observed household characteristics, such as household size and location, and U^i is a vector of unobserved attributes of the child, parents, and household, which affect the i^{th} child's health (nutritional status), examples being the child's genetic endowment, the parents' weight and height which were not measured, and unobserved household sanitation factors.

The maximization of (1) subject to (2) and the usual full income constraint, which combines both the time and budget constraints for household members leads to the following reduced form equations for the i^{th} child's health level (nutritional status) and food consumption (calorie consumption):

$$H^i, F^i = f^j (C, D, G, U, W, P, V) \qquad j = H^i, F^i \qquad (3)$$

where as previously defined, C and D are personal characteristics of household members, G are household level factors, U are unobserved factors, W are individual-specific market wage rates for household members, P represents a vector of food and non-food prices, and V is the household's non-labor income.

Estimation Procedure

In addition to being longitudinal, some other features of the data were important in selecting appropriate estimation procedures.[8] First, many children in the sample were not observed in all four survey rounds. For the preschool (13-83 months old) children, all four rounds of survey data were available for 44.8%, three rounds for 16.8%, two rounds for 22.9%, and only one round of data for 15.5%. Second, some of the explanatory variables used in the analysis could be expected to vary over time. However, other variables are essentially, or in some cases completely, time invariant. Examples of the latter are the child's gender or the province in which the household is located.

In the first estimating model the observations for a given child were averaged across the survey rounds available. Weighted-least-squares (WLS) regressions were then run with the averaged variables. WLS was used because averaging introduces heteroscedasticity since the number of survey rounds varies by individual. The square root of the number of survey rounds for that child was used as the weighing factor.[9] To simply pool the observations and apply OLS would ignore the possible correlation of the error terms for a given individual and would overstate the number of independent observations in the sample. Averaging the observations by individual and applying WLS to the averaged variables addresses this issue and also reduces the impact of measurement error on the regressors.[10]

The basic time series - cross section model assumed in this approach can be specified as:

$$H_i^t,\ F_i^t = X_i^t \beta^j + \epsilon_i^{tj} \qquad j = H_i,\ F_i \qquad (4)$$

where X represents all the exogenous explanatory variables, the subscript i denotes the child and the superscript t denotes the survey round. The first estimation procedure leads to the following specification:

$$\frac{\bar{H}_i}{\sqrt{m}},\ \frac{\bar{F}_i}{\sqrt{m}} = \frac{\bar{X}_i \beta^j}{\sqrt{m}} + \frac{\bar{\epsilon}_i^{j}}{\sqrt{m}} \qquad j = H_i,\ F_i \qquad (5)$$

where m equals the number of survey rounds for a given child.

With longitudinal data, the opportunity exists to remove the possible bias introduced by unmeasured or unobservable, individual-specific factors, such as the child's genetic endowment, which might be correlated with the included explanatory variables. The basic time series-cross section model would then be specified as:

$$H^{it}, F^{it} = X^{it}\beta^{j} + U^{i} + \epsilon^{itj} \qquad j = H^{i}, F^{i} \qquad (6)$$

where U^i is the individual-specific effect. If U^i is viewed as an unknown but fixed factor differing across individuals, then the so-called fixed effects model is the appropriate estimation procedure.[11] The fixed effects model is obtained by transforming the variables into deviations from the individual averages:

$$(N^{it} - \bar{N}^{i}), (F^{it} - \bar{F}^{i}) = (X^{it} - \bar{X}^{i})\beta^{j} + (\epsilon^{itj} - \bar{\epsilon}^{ij}) \qquad (7)$$

$$j = H^{i}, F^{i}$$

Since the U^i terms are fixed, they drop out of the model and unbiased and consistent estimates are obtained using ordinary-least-squares (OLS).[12] This model serves as a "drastic remedy for the effects of all time-invariant omitted variables".[13] For the estimation of the fixed effects model, only children with multiple observations were included and the 15.5% with only one survey round of data were excluded. Since some of the exogenous variables included in X^{it} varied little, if at all, over the 18 months covered by the survey rounds, they were dropped from the fixed effects analysis.

DATA AND VARIABLES

This section describes the variables used in the empirical analysis, starting with the dependent variables. The basic descriptive statistics (means and standard deviations) are given in table 1, along with a description of each variable. Infants less than one year old were excluded from the analysis, since different factors may affect their nutritional status and their nutrient intake is primarily obtained from breast or bottle feeding.

Dependent Variables

A food weighing method was utilized to obtain food consumption data for a 24-hour period for individuals in the subsample of households. Information on meals and snacks eaten outside the household was collected by recall, with the mother responding for young children. The specific indicators of the child's food consumption used in this analysis are 24-hour calorie intake and the child's calorie adequacy ratio. The calorie and protein content of each child's diet were determined using Philippine food composition tables for the various foods consumed. The calorie and protein adequacy ratio were then calculated by dividing the child's calorie intake by his or her recommended daily allowance (RDA) for calories and protein and multiplying by 100 to convert to a percentage basis. The RDA's developed by the Philippine Food and Nutrition Research Institute for Filipinos were used.[14] The RDA's are not individual-specific but are specified for age and gender categories.

The average calorie consumption of children (13-83 months) was 881 calories. They received only 60% of their RDA for calories. In comparison, the calorie adequacy ratio for all individuals in the survey households was 70% and the national average for the Philippines was 89%.[15] These figures are consistent with the purposeful selection of areas of high malnutrition, particularly among preschool children, for the pilot food subsidy program. The adequacy ratios for protein were substantially higher than for total calories among the surveyed individuals. Since energy intake was clearly a more serious constraint in the diet than protein, this study focuses on calorie consumption.

The anthropometric measurements used as indicators of nutritional status are the z-scores of height for age and weight for height. The standard deviation or z-score method is recommended by the World Health Organization.[16] In particular, the problem with the old method of just using the percent in relation to the reference population median values is that they are not equivalent for different ages and anthropometric measures.[17] The specific formula for the z-score is:

$$Z\text{ - score} = \frac{\left[\text{child's anthropometric value} - \text{median value of the reference population}\right]}{\text{standard deviation of reference population median}}$$

For example, to derive the z-score of height for age, the sample child's height is expressed as the number of standard deviations above or below the median for children in the reference population of the same age and gender. The z-scores for weight for height indicate the number of standard deviations from the median weight for children in the reference population of the same height. As recommended by the WHO, the National Center for Health Statistics data for U.S. children were used as the growth standards for the reference population.[18] Martorell and others defend the use of growth data for children in developed countries as norms for developing countries.[19] In comparisons of well-nourished preschool children from diverse ethnic groups, the anthropometric differences are quite small, especially compared to the very large differences within ethnic groups between malnourished and well-nourished children.

A rule of thumb for evaluating anthropometric z-scores has been developed with a score of less than -3.00 indicating "severe" malnutrition, between -3.00 and -2.01 "moderate" malnutrition, -2.00 to

-1.01 "mild" malnutrition, and -1.00 and above is considered normal.[20] The results for this breakdown are given in table 2 for the preschool children in the survey. In part (a) of table 2, the figures are from the pooled data in which the original data from each survey round for each child are the observations. In part (b), the observations for each child from the various survey rounds were first averaged before the figures were calculated. The results clearly indicate a population in which malnutrition among preschool children is a very serious problem, particularly in terms of stunting. As one would expect, averaging the observations for each child smooths out some of the more extreme observations, particularly in terms of weight for height, the current nutritional status indicator. The major difference between the results in parts (a) and (b) is that the proportion of children with "severe" wasting is reduced by over two-thirds by averaging the observations.

Independent Variables

The first set of exogenous variables shown in table 1 are related to the individual child and include the child's age in months, gender and birth order. A strong relationship has been observed in previous studies between age and gender and the child's nutrient intake and nutritional status. Recent work by Horton has shown that the child's birth order may also have a substantial impact on nutritional status.[21] Higher birth order children can suffer due to the increased strain on family resources, particularly in terms of the time available for child care. The birth order variable used in this analysis is for surviving children and starts with one for the oldest child, increasing by one for each additional child.

In the second category of independent variables in table 1, fathers in the sample were slightly older than the mothers. However, the mothers had completed slightly more schooling on average than the fathers. The parents' ages and education levels, particularly the mother's, might be expected to have a positive impact on preschooler nutritional status.. One can hypothesize that older and better educated parents should have improved child rearing skills. The estimated wage rates for fathers and mothers are approximately equal, which is unusual, since the average wage for men is typically higher than for women in developing countries. The similarity in the wage rates can perhaps largely be explained by the equal access of girls to schooling in the Philippines, which is reflected in the average education levels of the parents.

The procedure used to estimate wage rates for the fathers and mothers needs to be briefly explained. The surveys acquired time allocation data for the husbands (fathers) and wives (mothers), which could be combined with the individual earnings data to calculate market wage rates for those individuals who were employed in the labor force. Since only 14% of the wives and 55% of the husbands had market jobs, shadow wage rates were predicted for all husbands and wives from wage equations estimated for those who were employed. The 18 months covered by the four surveys were a period of considerable inflation in the Philippines. Therefore, wages were deflated by the Consumer Price Index with a base year of 1978.

Because an individual's employment status reflects self-selection, the Heckman procedure was used to correct for the possible sample selection bias.[22] Separate probit equations were first estimated for husbands and wives to explain their labor force participation. The inverse of the Mill's ratio, which reflects the probability that an observation with specific characteristics will be selected into the truncated sample of employed persons, was obtained from each probit equation. More formally, the Mills ratio is the ratio of the ordinate of a standard normal to the tail area of a distribution.

The explanatory variables used in the wage estimation equations were the individual's age, age squared, education, seven village-specific location variables, and the inverse of the Mill's ratio, which corrects for possible selection bias. Wages were estimated separately for husbands and wives. The results were consistent with previous studies for the Philippines.[23] Finally, an estimated market (shadow) wage rate was predicted for every husband and wife irregardless of their employment status.

Most households were nuclear families, with a husband and wife and their children. As shown in table 1, the average household had just under seven persons and slightly over one-third of those individuals were children less than seven years old. The latter variable serves as a measure of the child care burden on older family members, particularly the mother. The higher the proportion of young children in a family the less time one would expect to be allocated to the care of each preschooler. The most common form of toilet facility was an antipolo or privy, which along with water-sealed flush toilets were coded as sanitary. Less adequate sanitation could adversely affect the health of family members, which would be reflected in the growth rates of the children.

Prices for two major staples, rice and cooking oil, were included as explanatory variables. Price data were collected in the household surveys and reflect both spatial variation across the three widely separated regions included in the study and variation across the four survey rounds. As with wages, prices were deflated by the Consumer Price Index with a base year of 1978.

Two nutrition education programs were in operation in the study areas. The first, the Philippine Nutrition Program, which was a government program begun in 1974, reached over 80% of the households. A second nutrition education program was introduced in conjunction with the food price subsidies in selected villages. The latter program used face-to-face sessions supplemented by handout material, and was primarily aimed at the mothers.[24]

The households in some villages received both a rice and cooking oil subsidy and in some only cooking oil was subsidized. Several villages received no subsidy and served as a control group. The initial price subsidy was 32% for rice and 50% for cooking oil. Since not all the household surveyed participated in the pilot food subsidy scheme, the mean given in table 1 understates the value to those which did. The weekly value in 1978 pesos averaged 5.34 pesos for those households receiving a subsidy. The impact of the food subsidy on preschoolers is an important policy issue. In addition, in the context of the New Household Economics model the value of the food subsidy can be viewed as a form of non-labor income, which is an exogenous factor not influenced by the value of time or the time allocation decisions of household members.

The three provinces in which the study was conducted were Abra, Antique, and South Cotabato. Abra is an upland tobacco and subsistence corn area, located in northern Luzon, the major island of the Philippines. Antique is a coastal fishing and marginal rice farming area, located in the middle of the island archipelago. South Cotabato is a river basin primarily devoted to corn production and is located on the southern island of Mindanao.

EMPIRICAL RESULTS

This section presents and discusses the regression results for the reduced form equations for child food consumption (measured in terms of calorie intake and the calorie adequacy ratio) and child nutritional status (as indicated by height for age and weight for height). Table 3 gives the results for the weighted least squares regressions in which the observations for each child were averaged across the available survey rounds. Table 4 provides the results for the fixed effects model, in which the observations were deviations from the child-specific means for each variable. Tables 3 and 4 give the estimated coefficients, t-statistics, and indicate whether a variable is statistically significant at a 10% or 5% level.

WLS Child Average Estimates

In the first two regressions in table 3, the child's age has a statistically significant, positive impact. This result is certainly not surprising for calorie intake; for the calorie adequacy ratio it is more informative. Furthermore, the relationship between age and the child's calorie adequacy ratio is non-linear. The age squared term is also statistically significant. Boys do better than girls both in terms of their calorie intake and adequacy ratio, which is a pattern which has been observed in numerous previous studies.[25] Birth order did not have a significant effect. Neither the parents' ages, education levels, wage rates nor the household's size, the percent of young children, the type of toilet; prices; or nutrition education have a statistically significant effect. The next statistically significant factor is the food subsidy program which had a beneficial impact on calorie intake and the calorie adequacy ratio.[26] A one peso increase in the value of the weekly food subsidy (in 1978 pesos) increased the food consumption of preschoolers by 15 calories per day. Finally, young children appear to eat more in Antique than in the other two provinces.

Previous studies suggest that the relationship between nutritional status and age may be non-linear.[27] Initial regressions for height for age and weight for height were run with both the child's age and an age squared term as variables. However, in those regressions neither the age or age squared variables were statistically significant and the latter was dropped to see if there was a simple linear relation. Gender and birth order both affect stunting, but not wasting. Boys are more stunted in relationship to the standard for their age than girls. Also higher birth order children suffer more stunting. Horton found that birth order had a significant negative effect on both chronic and current nutritional status.[28]

The long-run nutritional status of children benefits from the increased education of both parents. This effect is separate from the impact of increased education on the parents' estimated wages. Strauss also found that the parents' education levels had a significant beneficial impact on their children's nutritional status.[29] Wolfe and Behrman have stressed the importance of the mother's schooling, in particular, as a determinant of child nutritional well-being.[30]

Both the father's and mother's estimated wages affect long-run nutritional status, and the mother's wage has a statistically significant impact on current status. Since reduced form equations are estimated, a particular regression coefficient may intermix several structural effects. In this case, the wage rate coefficients might be expected to reflect not only the impact of the value of time on the time allotted to household production of child nutritional status, but also a full income effect and possibly even an intrahousehold distribution effect. The latter would be the case if individuals with higher real or potential wages had a greater influence on the allocation among household members of food and other resources which affect nutritional status.[31]

The negative sign of the estimated wage parameters in the height for age regression suggests that the value of time effect, which is expected to be negative, and/or the intrahousehold allocation effect, which might be negative, tend to dominate the full income effect, which is presumed to be positive. On the other hand, the positive impact of the mother's shadow wage on weight for height can perhaps be attributed to a positive full income effect and an intrahousehold allocation effect, which may be positive.[32]

The next significant factor is the price of rice, which curiously is negative in the stunting equation and positive in the wasting regression. Again, since the estimating equations are reduced forms, two effects may be intermixed in the coefficient estimates for rice. The basic price effect of higher rice prices would be expected to reduce rice consumption. However, at least for rice farming households higher rice prices would have a substantial income effect which could have a positive impact on the children's nutritional status.

A possible explanation for the difference in the direction of the rice price effect in the two equations rests on possible shifts in the diet between the preferred staple, rice, and inferior staples, such as corn and root crops, as relative prices change. If the relative price of rice increases, rice consumption is decreased and the households substitute more corn and root crops into their diets. Corn and root crops are a cheaper source of calories than rice and more calories can be purchased, so that short-run nutritional status improves. However, the protein content of corn and root crops is lower than that of rice, so that the growth of the children suffers and stunting increases. The positive rice price effect in the calorie intake equation, which is almost statistically significant at the 10% level, is consistent with this explanation.

The food subsidy reduced stunting, but not wasting among preschool children. The food subsidy also had a positive and significant effect in a regression with the z-score of weight for age as the dependent variable, which is not shown in table 3.[33] Finally, children (13-83 months) appear to suffer less stunting in South Cotabato and more wasting in Antique and South Cotabato than in Abra province.

An overall appraisal of the regressions indicates it is not easy to explain a large proportion of the variation in nutritional status among preschool children. A caution is necessary regarding the R^2 statistics since averaging the data tends to increase the R^2 value.[34] The F-ratios indicate statistical significance at the 1% level or better for each of the four regressions in table 3. The sample sizes reveal the loss of some observations because of missing values, which should not be surprising given the substantial number of explanatory variables and the multi-survey nature of the data.

Fixed Effects Estimates

The list of explanatory variables in table 4 is substantially shorter than in table 3. Those variables which were either time-invariant or varied only slightly over the period covered by the four survey rounds were dropped. The variables dropped included the child's gender, the parents' ages and education levels, toilet facilities, the pilot nutrition program, and the province. An initial set of fixed effects regressions were run which included intercept terms. However, the fixed effects model does not suggest a constant term is necessary, nor was it significant in any of the equations, and was, therefore, deleted.

In the first two equations in table 4, the estimated coefficients for the child's age are positive and for birth order are negative, but none are significant at the 10% level. The only significant wage effect is the negative impact of the father's estimated wage on the child's calorie intake. A one peso increase in the father's wage which represented a 68% increase in relation to the average wage of 1.46 pesos per hour, was related to a decline in the child's food consumption of 197 calories per day. An intrahousehold food distribution effect is the most likely explanation for this very substantial negative impact.

Household size has a positive and significant effect in both the calorie intake and adequacy equations. An increased household size, particularly since the percent of children less than seven was included as a variable and thus held constant, means an increase in the family members who are adults and older children. With more potentially, economically active family members, the household's full income, and very likely the household's earned income increase. The household size variable may, therefore, be largely capturing an income effect. And finally, the calorie consumption of preschool children was improved by the food subsidy. The subsidy variable also has a positive effect in the adequacy ratio equation, but is not significant at the 10% level.

In the nutritional status regressions, both anthropometric measurements improved with the child's age. The effect of birth order on weight for height was negative and significant, which is consistent with Horton's results that also came from a fixed effects model.[35] Both the father's and mother's estimated wages have a significant impact on the child's long-run nutritional status. Stunting increased among preschool children as the father's wage increased and decreased as the mother's wage rose. These results are in line with the findings of Senauer, Garcia and Jacinto that the father's estimated wage had a negative effect on the intrahousehold allocation of resources to children and the mother's wage a positive impact.[36] The positive intrahousehold allocation effect of the mother's wage dominates the presumably negative impact that the increased value of time has on her allotment of time to child care in the health (nutritional status) production process.

The results for the price of rice have the same pattern as in the WLS equations reported in table 3. The price of rice has a negative impact on height for age and a positive effect on weight for height. The reasons presented previously can perhaps explain this dichotomy. The price of cooking oil has a negative and significant effect on weight for height. Cooking oil has a very high caloric density and a decline in its price leads to children gaining weight in relation to their height. Finally, the current nutritional status of children was improved by both the food subsidy program for rice and cooking oil and the Philippine government's nutrition education program. These last results suggest that government can intervene to improve, at least the current, nutritional status of preschool children.

In terms of an overall appraisal of the four equations, only a small proportion of the deviation of a child's food consumption or nutritional status from his/her average values can be explained. The advantage, of course, of the fixed effects model is the removal of any possible bias due to unmeasured or unobservable time-invariant factors. The F-statistics do indicate that each of the equations is statistically significant at least at the 1% level.

CONCLUSIONS

This study has examined factors which influence the food consumption and nutritional status of preschool children in a developing country. Child nutritional status was treated as the outcome of a household production process. Care was taken to distinguish between endogenous and exogenous factors and reduced form equations were estimated. Two estimation procedures were utilized to take full advantage of the longitudinal data available for three rural provinces in the Philippines. The three provinces were areas in which poverty and malnutrition were serious problems. The results of this analysis have important policy implications. Effective policies and programs to alleviate malnutrition among preschool children require an understanding of the underlying determinants.

The results of this analysis support the previous finding that the nutritional status of higher birth order children suffers. This pattern implies that family planning programs which successfully encourage parents to have fewer children, can be an effective means of reducing childhood malnutrition. The results for education tend to confirm previous evidence that the nutritional status of children benefits from increased parental schooling. This effect represents one more reason to make universal primary education a major policy objective in developing countries.

This study also suggests that the value of time of the parents can affect the nutritional status of their children. In particular, increases in the father's estimated wage rate has a negative impact on the nutritional status of his preschool children, which may be due to the effect of wage rates on the intrahousehold allocation of resources. Although there is an exception, these results, particularly when combined with the previous findings of Senauer, Garcia, and Jacinto, suggest that increases in the mother's value of time may generally tend to improve the nutritional status of her preschool children. In addition, this analysis finds a relationship between childhood nutritional status and the price of the staple food, in this case rice. The direction of the rice price effect, which differs between the two nutritional status equations, can perhaps be explained by a pattern of substitution between rice and the less preferred, cheaper starchy staples. Since the estimated coefficients in this analysis intermix structural effects, further research is needed to analyze the underlying structural relationships.

This analysis supplies strong evidence that the food subsidy program was quite successful at improving the calorie consumption and nutritional status of preschoolers. These findings reinforce the previous conclusions concerning the effectiveness of the food subsidy scheme. Perhaps the most convincing proof comes from the fixed effects equations. The Philippine pilot food subsidy scheme deserves careful examination for lessons that may be learned concerning the design and implementation of nutrition intervention programs, which have the reduction of malnutrition among preschoolers as an objective.

Finally, this study demonstrates the research value of the kind of extensive longitudinal data for both the individual and household, which were collected in conjunction with the pilot food subsidy scheme in the Philippines. Such data allow the researcher to more completely exploit the rich theoretical framework provided by the New Household Economics, in which health (nutritional status) is viewed as the result of a household production process. In addition to the standard personal characteristics and household variables, these data allowed estimates for the father's and mother's value of time and prices of two key foods to be included in the analysis as explanatory factors. Moreover, the multiple observations for an individual allowed the utilization of a fixed effects model which removes the impact of any unobserved, child-specific, time-invariant factors. This capability seems particularly relevant in an analysis of nutritional status, since the child's genetic endowment and other unobservable factors are likely to be important determinants. Hopefully, others will be encouraged to collect such detailed longitudinal data on individuals in household surveys.

FOOTNOTES

[1] For a discussion regarding malnutrition among preschool children and its implications, see James E. Austin, Confronting Urban Malnutrition: The Design of Nutrition Programs, World Bank Staff Occasional Paper No. 28, Baltimore: John Hopkins University Press, 1980, pp. 14-15; Eileen Kennedy, "Analysis of the Determinants of Preschooler Nutritional Status", (mimeographed) Washington, D.C.: International Food Policy Research Institute, March 11, 1983; Reynaldo Martorell, "Nutrition and Health Status Indicators: Suggestions for Surveys of the Standard of Living in Developing Countries", World Bank Living Standard Measurement Study, Working Paper No. 13, February 1982, pp. 7 and 74; Meredith F. Smith, Steven K. Paulsen, William Fougere, and S.J. Ritchey, "Socioeconomic, Education, and Health Factors Influencing Growth of Rural Haitian Children", Ecology of Food and Nutrition 13 (1983): 99-108.

[2] A number of previous studies have analyzed the determinants of child nutrition status. Some of the most relevant to this study are: Josephine R. Battad, "Nutritional Status of Preschoolers", The Philippine Economic Journal 17 (1978): 154-167; Susan Horton, "Child Nutrition and Family Size: Results from the Philippines", Journal of Development Economics 27 (1986): 55-76; Susan Horton, "Birth Order and Child Nutritional Status: Evidence from the Philippines", Economic Development and Cultural Change 36 (January 1988): 341-354; John Strauss, "Households, Communities, and Preschool Children's Nutrition Outcomes: Evidence from Rural Cote d' Ivoire", (mimeographed), Economics Department, Yale University, March 1987.

[3] For a detailed description of the study areas, the pilot food subsidy program and the survey methodology, see Marito Garcia and Per Pinstrup-Andersen, The Pilot Food Price Scheme in the Philippines: Its Impact on Income, Food Consumption, and Nutritional Status, International Food Policy Research Institute, Research Report No. 61, Washington, D.C., August 1987.

[4] Common usage is to refer to "calories", but the unit of measurement is actually "kilocalories".

[5] Strauss, pp. 1-2.

[6] Gary S. Becker, "A Theory of the Allocation for Time", Economic Journal 75 (1965): 493-517.

[7] Mark M. Pitt and Mark R. Rosenzweig, "Health and Nutrient Consumption Across and Within Farm Households", Review of Economics and Statistics 67 (1985): 212-223.

[8] For an overview of various estimation models for pooled cross-section/time-series data, see G.S. Maddala, Econometrics, New York: McGraw-Hill, 1977, pp. 320-333.

[9] Maddala, p. 268.

[10] One degree of freedom was lost for each child, when the child

means were calculated for each variable.

[11] James A. Hausman, "Specification Tests in Econometrics", Econometrica, 46 (November 1978): 1251-1272.

[12] The random effects model is an alternative specification of the time series-cross section model in which the U_i term is viewed not as fixed by as normally distributed with a mean of zero and variance of σ^2_μ and is uncorrelated with both ϵ_i and X_{it}. If U_i is correlated with ϵ_i and X_{it}, then the random effects estimator will not be unbiased and consistent, whereas the fixed effect estimator will (see Hausman, pp. 1261-1263).

[13] Maddala, p. 327.

[14] Virginia S. Claudio, Patrocenio E. DeGuzman, Moninia S. Oliveros, and Gemma P. Dimaamo, Basic Nutrition for Filipinos, Manila: Merriam Corp., 1982.

[15] Benjamin Senauer, Marito Garcia, and Elizabeth Jacinto, "Determinants of the Intrahousehold Allocation of Food in the Rural Philippines", (mimeographed), University of Minnesota, June 1987.

[16] World Health Organization, Measuring Change in Nutritional Status, Geneva, 1983.

[17] A more complete explanation of the advantages of the z-score approach is provided in Martorell, p. 47.

[18] World Health Organization, Measurement of Nutritional Impact, Geneva, WHO document no. FAP/79.1, November 1979.

[19] Martorell, p. 43 and Kennedy, p. 13.

[20] Horton, 1986.

[21] Horton, 1988.

[22] James J. Heckman, "Sample Selection Bias as Specification Error", Econometrica 47 (1979): 153-161.

[23] Robert E. Evenson, Barry M. Popkin, and Elizabeth K. Quizon, "Nutrition, Work and Demographic Behavior in Rural Philippine Households", in Rural Household Studies in Asia, (ed.) Hans P. Binswanger, Robert E. Evenson, Cecilia A. Florencio, and Benjamin N.F. White, pp. 289-364, Singapore: Singapore University Press, 1980; Raul V. Fabella, "Economies of Scale in the Household Production Model and Intra-Family Allocation of Resources", Ph.D. dissertation, Yale University, 1982; Alejandro N. Herrin, "Female Work Participation and Fertility in a Philippine Setting: A Test of Alternative Models", Discussion Paper No. 8005, School of Economics, University of the Philippines, October 1980.

[24] For more complete information on the nutrition education program, see Garcia and Pinstrup-Andersen, p. 16.

[25] U.S. Department of Agriculture, Nutrition Economics Group, Office of International Cooperation and Development, "Intra-Family Food Distribution: Review of the Literature and Policy Implications", Washington, D.C., August, 1983.

[26] This was also the finding of Garcia and Pinstrup-Andersen, pp. 82-83.

[27] Horton, 1986; Horton, 1988, and Strauss.

[28] Horton, 1988.

[29] Strauss, p. 14.

[30] Jere R. Behrman and Barbara L. Wolfe, "More Evidence on Nutrition Demand: Income Seems Overrated and Women's Schooling Underemphasized", Journal of Development Economics 14 (1984): 105-128; Barbara L. Wolfe and Jere R. Behrman, "Determinants of Child Mortality, Health and Nutrition in a Developing Country", Journal of Development Economics 11 (1982): 163-193.

[31] For an analysis of the intrahousehold allocation of food in Philippine households, see Senauer, Garcia and Jacinto.

[32] An increase in the mother's estimated wage improved the relative intrahousehold allocation of food to children, see Senauer, Garcia, and Jacinto.

[33] These findings concerning the food subsidy agree with the results of one of the models estimated by Garcia and Pinstrup-Andersen, pp. 87-89.

[34] Jan Kmenta, Elements of Econometrics, New York: MacMillian, 1971, p. 327.

[35] Horton, 1988.

[36] Senauer, Garcia, and Jacinto.

Table 1. Variables and Descriptive Statistics

Variables	Mean	Standard Deviation
Dependent Variables[a]		
24-hour calorie consumption	881	387
Calorie adequacy ratio (calorie consumption/ recommended daily allowance for calories)	60	25
Z-score for height for age	-2.02	2.01
Z-score for weight for height	-.54	1.62
Child related variables:		
Age in months	43.42	18.48
Gender (1 if male, 0 if female)[b]	.51	
Birth order	3.40	2.09
Father and mother variables:		
Father's age in years	35.74	7.67
Mother's age in years	32.25	6.93
Father's education in years	6.99	3.56
Mother's education in years	7.54	3.53
Father's estimated wage rate in 1978 pesos per hour	1.46	1.50
Mother's estimated wage rate in 1978 pesos per hour	1.44	1.15
Household variables:		
Household size (number of persons)	6.62	2.14
Percent of the household members who are children less than 7 years old	34.57	15.91
Toilet facilities (1 if sanitary, either water-sealed/flush or a privy; 0 otherwise)	.64	
Price of rice in 1978 pesos per kilogram	2.88	.88
Price of cooking oil in 1978 pesos per kilogram	19.25	22.17
Nutrition education (1 if the household participated in the Philippine Nutrition Program; 0 otherwise)	.81	
Pilot nutrition education (1 if the household participated in the program run in conjunction with the food subsidy study; 0 otherwise)	.51	
Value of the food subsidy for rice and cooking oil in 1978 pesos per week	2.93	5.15
Antique Province (1 if in province; 0 otherwise)	.41	
South Cotabato Province (1 if in province; 0 otherwise)	.32	

[a] The data relate to children ages 13-83 months.

[b] For the dummy variables, the zero and one observations were averaged and the mean indicates the proportion of observations with a value of one.

Table 2. Z-Score Classification of Nutritional Status of Children 13-83 Months

a.) Original data

Z-score Categories	Degree of Malnutrition	Percent of Sample by Z-score Category Height/age	Weight/height
Below -3.00	severe	24.2	10.4
-3.00 to -2.01	moderate	26.9	9.1
-2.00 to -1.01	mild	23.3	20.2
-1.00 and above	normal	25.6	60.2

b.) Averaged data

Z-score Categories	Degree of Malnutrition	Percent of Sample by Z-score Category Height/age	Weight/height
Below -3.00	severe	24.3	3.1
-3.00 to -2.01	moderate	27.3	9.2
-2.00 to -1.01	mild	24.5	23.3
-1.00 & above	normal	23.9	64.4

Table 3. Weighted Least Squares Regression Results[a]

Independent Variables	Calorie Intake	Calorie Adq. Ratio	Height/age	Weight/height
Intercept	-45.42	.026	-.696	-1.53**
	(.12)	(.09)	(1.10)	(2.96)
Child's age	18.75**	.014**	-.004	.003
	(3.49)	(3.56)	(1.55)	(1.29)
Child's age squared	-.087	-.0001**	--	--
	(1.48)	(2.50)		
Gender	115.24**	.070**	-.182**	-.044
	(3.50)	(2.90)	(2.14)	(.64)
Birth order	-7.51	-.005	-.125**	.049
	(.35)	(.29)	(2.54)	(1.22)
Father's age	-1.98	-.002	.015*	-.007
	(.50)	(.59)	(1.79)	(.97)
Mother's age	3.36	.002	.010	.010
	(.86)	(.87)	(.88)	(1.17)
Father's education	-2.35	-.003	.039**	-.010
	(.45)	(.66)	(2.67)	(.84)
Mother's education	3.88	.003	.030**	.017
	(.70)	(.66)	(2.04)	(1.38)
Father's est. wage	63.89	.061	-.524**	-.161
	(.70)	(.93)	(2.25)	(.84)
Mother's est. wage	-6.27	-.011	-.924**	.641**
	(.10)	(.25)	(5.65)	(4.79)
Household size	-18.06	-.014	.021	-.043
	(.96)	(1.02)	(.51)	(1.27)
Percent children <7	.688	.001	.0001	-.0002
	(.46)	(.49)	(.02)	(.07)
Toilet	-40.55	-.031	-.063	.101
	(1.05)	(1.09)	(.62)	(1.23)

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Table 3. (continued)

Independent variables	Calorie Intake	Calorie Adq. Ratio	Height/age	Weight/height
Price of rice	65.60 (.78)	.053 (.85)	-.104* (1.89)	.076* (1.68)
Price of cooking oil	.432 (.37)	.0002 (.19)	.002 (.77)	-.00003 (.01)
Nutrition education	-34.35 (.53)	-.029 (.60)	-.067 (.39)	.163 (1.18)
Pilot nutrition program	-14.92 (.47)	-.010 (.43)	.100 (1.15)	-.130* (1.83)
Food subsidy value	15.87* (1.74)	.012* (1.77)	.048** (2.86)	-.006 (.43)
Antique	187.01** (2.38)	.140** (2.43)	-.045 (.29)	-.490** (3.95)
South Cotabato	-59.99 (1.27)	-.053 (1.55)	.74** (5.95)	-.476** (4.72)
R^2	.52	.32	.08	.06
F Ratio	10.70	4.73	5.72	4.34
Sample Size	221	221	1,237	1,237

[a] t-statistics are given in parentheses below the coefficients
*denotes significant at the 10% level and ** at the 5% level

Table 4. Fixed Effects Model Regression Results[a]

Independent variables	Calorie Intake	Calorie Adq. Ratio	Height/age	Weight/height
Child's age	.318	.015	.029**	.009**
	(.92)	(1.60)	(8.02)	(2.22)
Birth order	-108.37	-.233	.059	-.243**
	(1.63)	(1.22)	(.87)	(2.98)
Father's est. wage	-196.72**	-.116	-.233**	.095
	(2.00)	(.41)	(2.24)	(.76)
Mother's est. wage	24.96	-.050	.147**	-.092
	(.60)	(.42)	(2.05)	(1.07)
Household size	138.99**	.157**	.009	.112**
	(4.99)	(1.98)	(.31)	(3.05)
Percent children <7	.336	.001	.001	-.002
	(.25)	(.15)	(.89)	(1.23)
Price of rice	65.03	-.022	-.211**	.293**
	(1.55)	(.18)	(3.93)	(4.56)
Price of cooking oil	-.462	.0005	.0005	-.002**
	(.71)	(.27)	(.59)	(2.12)
Food subsidy value	7.45**	.017	.003	.011**
	(1.93)	(1.52)	(.72)	(2.19)
Nutrition education	20.58	-.045	-.023	.110**
	(.54)	(.41)	(.50)	(1.96)
R^2	.09	.04	.07	.03
F Ratio	4.69	2.14	18.21	7.99
Sample size	476	476	2,320	2,320

[a] t-statistics are given in parentheses below the coefficients
* denotes significant at 10% level and ** at the 5% level