

CHILD NUTRITION, DIET AND  
SOCIOECONOMIC STATUS IN RURAL PUNJAB

Dov Chernichovsky  
Center for Health  
Sciences  
Ben Gurion Univ.  
Beer Sheva, Israel

Arnfried A. Kielmann  
Dept. of International  
Health  
The Johns Hopkins Univ.  
Baltimore, Maryland

Working Paper 82-3

נייר עבודה 82-3

June 1982

## ABSTRACT

Malnutrition is a major cause of child disease, growth and development retardation, and mortality in many developing areas. Relatively little has been done to quantify the link between socioeconomic conditions and the nutritional status of preschool children.

This paper attempts to measure the role that children's diet plays in their physical growth, and to relate their dietary intake to their socioeconomic environment. An analytical framework is presented in which to examine the relationships between diet, growth and socioeconomic status. The data, which were collected from a sample of 173 children in rural India, aged 1-36 months, are then used to estimate these relationships.

The results show a clear colleration between children's socioeconomic environment and their nutritional status. Children of landowners, in the highest socioeconomic group, are heavier and taller than children in the middle and low socioeconomic groups. Children in the highest and lowest groups, both of which represent agricultural occupations, have better diets than other children, as measured by calorie consumption. Nonetheless, children in the middle group appear able to attain the same growth levels with smaller diets. This suggests that their parents maintain better housing and sanitary conditions and are more knowledgeable about child nutrition than parents in agricultural occupations. They thus incur a smaller loss of diet due to disease.

The findings of this paper present certain short-run policy implications. The lowest socioeconomic group appears to be the most in need of an aid package consisting of diet supplementation and disease control; the highest group is primarily in need of disease control.

Child Nutrition, Diet and  
Socioeconomic Status in Rural Punjab

Dov Chernichovsky  
Center for Health Sciences  
Ben Gurion University  
Beer Sheva, Israel

and

Arnfried A. Kielmann  
Department of International  
Health  
The Johns Hopkins University  
Baltimore, Maryland

1. Introduction

Malnutrition has been regarded as the major cause of child disease, retardation in growth and development, and mortality in many developing areas (Behar, 1968). Over the past two decades many research projects and service programs have been carried out in order to determine and measure the dynamics of this relationship and to find effective means of intervention (Davidson et al., 1980). Many interventions have focused on improving levels of nutrition or health through dietary supplementation and control of infection in populations of preschool children and pregnant women, such as the programs carried out in India (Taylor et al., forthcoming), Guatemala (Klein et al., 1977), and Mexico (Cravioto et al., 1966). Relatively little has been done in the way of quantifying the link between socioeconomic conditions and nutritional risk in preschool children. Information concerning such a link would provide important data for efficient interventions.

In this paper we attempt, on the basis of a sample of children from rural India, to measure the role children's diet plays in their physical

growth, and relate these children's dietary intakes to their socioeconomic environment. First, an analytical framework in which to consider the relationships among children's diet, growth, and socioeconomic status is offered, in the section which follows. Then, by using the available data, which is described in the third section, these relationships are estimated to determine whether and how socioeconomic conditions relate to children's growth and diet. The results are reported in section four.

## 2. Conceptual Framework<sup>1</sup>

Children's growth, health, and diet are interdependent. From a behavioral viewpoint, we assume that although constrained by genetic and biological factors, parents can -- subject to a variety of socioeconomic constraints -- influence the growth of their children by choice of diet and inputs in children's health such as parental care, medical care, sanitary conditions, etc.<sup>2</sup>

To formalize the interdependency among growth, health, and diet, we begin by relating the initial diet,  $D_0$ , of a healthy newborn to his birth-weight, BW, which indicates initial health, appetite, and muscular development, and to socioeconomic conditions,  $E_0$ , which determine the quality and quantity of the child's diet. Socioeconomic

---

<sup>1</sup> This framework is drawn from Chernichovsky and Coate (1980).

<sup>2</sup> Diet and growth can be health measures in their own right. Here they are separated; "health" relates to prevalence of disease. See Chernichovsky (1979).

conditions predispose an infant to environmental effects through nutrition and hygiene, particularly after weaning. Formally,

$$D_0 = f(BW, E_0); \quad (1)$$

the infant's initial diet is expected to be quantitatively and qualitatively a positive function of both his birth weight and his socioeconomic environment.

In each subsequent (age) period,  $t$ , ( $t = 1 \dots T$ ) the child's growth,  $G_t$ , is assumed to be determined by various genetic and parental traits,  $Z$ ; his diet in the preceding period,  $D_{t-1}$ ; and his health in that period,  $H_t$ . Health can be interpreted in this context as an efficiency parameter in the sense that a healthier child makes better use of a given diet than a sick child. Formally,

$$G_t = g(Z, D_{t-1}, H_t). \quad (2)$$

The child's growth in each period (age) is expected to be typical of his sex group, and similar to some parental traits; for example, taller parents will have taller children. Controlling for age, sex and parental traits -- all represented by  $Z$  -- we expect healthier children with better diets to grow more.<sup>2</sup>

---

<sup>2</sup> Parental traits like height and weight of father and mother are not entirely genetic parameters. In a general framework, the parents' growth and development, as their children's, is determined by their own socioeconomic background.

The diet in each period after birth is a function of the child's growth, which serves as a proxy also for the child's appetite, or his demand for food; and of his socioeconomic status. Thus,

$$D_t = f(G_t, E_t). \quad (3)$$

It is further recognized that the child's health status, particularly his immunity from infectious diseases, is a function of his diet in addition to the direct effect of other factors, like housing and maternal care that are, in turn, also determined by socioeconomic status, so that

$$H_t = h(D_t, E_t). \quad (4)$$

To identify statistically some key relationships with the available cross-sectional data, several assumptions are necessary. Some of these are explicit in relationships (1) - (4). First, birth weight is considered not to be determined by any of the factors presented in the model. A more sophisticated model could include birth weight as a variable determined by parental characteristics and socioeconomic conditions.<sup>4</sup> Secondly, children who died ( $H_t = 0$ ) are excluded from the analysis. Thirdly, for empirical reasons, we assume that some variables, household income and children's diet, are serially correlated, while others, parents' traits and occupation, are constant. We also assume that the time increments are infinitesimal.

---

<sup>3</sup> Level of  $H_t$  may assume the value of "0" when a child dies. Indeed, a complete recursive model must allow for this possibility, which should eventually account for the selectivity bias in the data analysed.

<sup>4</sup> Hammond argues that the fetus is protected from environmental effects, including moderate maternal malnutrition (Hammonds et al., 1972). This view implies that nutrient intakes of the mother and socioeconomic variables could be removed from a birth weight equation. This theory is challenged by various researchers (Lechtig et al., 1975; and Habicht et al., 1974).

These assumptions permit us to write the following "reduced form" relationships

$$G = \phi_1(t, Z, BW, E), \quad (5)$$

and 
$$D = \phi_2(t, Z, BW, E), \quad (6)$$

$$H = \phi_3(t, Z, BW, E), \quad (7)$$

where  $t$  denotes the time dimension, given by the child's age. Relationships (5) - (7) relate child growth and diet to parameters that, within this partial analysis, are regarded as control variables or assumed external (exogenous) to the parents' decision-making process.

Estimation of these relationships provides knowledge of the total effect of  $E$  (or any other exogenous variable) on any of the outcomes: diet, growth, and health (disease). Relationships (5) - (7) conceal, however, the particular intervening mechanism through which any particular exogenous variable affects each outcome. For example, socioeconomic status ( $E$ ) may affect child growth through improved diet as well as through other inputs in good health. This mechanism may be crucial for establishing efficient interventions.

To particularize the effect of  $E$  through the diet, we must resort to relationships (2), (3), and (4) which specify the complex interrelations of the three main factors of interest: diet, growth, and health. According to (2) growth is a function of diet and health, and according to (3) diet is a function of growth. Health is in turn a function of diet, as is indicated in (4). Taken together, we have the following codetermined

system of simultaneous equations:

$$\hat{G} = g(\hat{D}, \hat{H}, Z, BW, t) \quad (8)$$

$$\hat{D} = f(\hat{G}, E) \quad (9)$$

$$\hat{H} = f(\hat{D}, E).^5 \quad (10)$$

In summary, children's growth, diet, and health affect each other, and are all mutually determined by a set of biological, genetic, and economic parameters.

### 3. The Data

Between 1969 and 1973, the Department of International Health of The Johns Hopkins University investigated the interactions of nutrition and infections and their effects on child growth, disease experience, and mortality in 10 villages of Punjab, North India.<sup>6</sup>

This discussion is based on a sample of 173 children aged 1-36 months whose dietary intakes and growth were recorded along with household socio-economic and demographic data. Due to a lack of information on some variables, this sample had to be reduced for some of the analyses.

---

<sup>5</sup> The notation "  $\hat{\phantom{x}}$  " indicates that the variable is an outcome determined by the entire system of relationships.

<sup>6</sup> A detailed description of study objectives research design and results is provided by Taylor et al. (forthcoming).

Table 1 shows the variables available for analysis, their role in the conceptual model defined by (8) - (10), the numbers of valid observations, as well as the mean and standard deviation of each variable. A key variable missing in this particular data set is the child's birth weight, which is presumably a key predictor to his nutritional status at an early age.

These statistics indicate that the sample is equally divided between boys and girls. These children have an average age of two years, an average weight of 9.5 kg. (compared with about 12 kg. for a similar group in the U.S.), and an average height of approximately 80 cm. (compared with approximately 85 cm. for the U.S. group). Children's height and weight are growth indicators. Height is a long-run indicator; weight is a short-run indicator which is subject to short-term variations.

Consumption levels of calories and calcium were used as proxies for the children's entire diet. These variables were employed one at a time because of the high correlation between them. Calcium, which approximates milk protein, appeared more significant statistically in estimates which relate to height; whereas calories, in weight-related estimates.<sup>7</sup>

Diarrhea, which was prevalent 6.7 days per 100 child days of observation, was used as a general indicator of health.<sup>8</sup> It is associated with nutrient loss because of poor absorption of nutrients from the gut and be-

---

<sup>7</sup> Almost all of the calcium ingested by children in the examined age range was derived from milk.

<sup>8</sup> Kielmann and McCord (1977).

cause of the cultural practice to decrease food intake of the afflicted child. It accounted for almost 40 percent of all deaths in the child population from which this sample was drawn. It was therefore expected to affect weight and, ultimately, height.<sup>9</sup>

Age, sex, and maternal height served as proxies for genetic and maternal traits. Occupational group and area of land cultivated served as proxies for socioeconomic status. Land cultivators who owned their land made up 38 percent of the sample; civil servants (teachers, police, etc.), artisans and self-employed, 18 percent; and agricultural laborers, 44 percent. From our earlier work we know that this hierarchy of occupations presents, in a descending order, the relative economic status of the groups. This status was also approximated by the area of land cultivated by each household.

#### 4. Empirical Analysis

The analytical framework already takes into account some of the data limitations. Because of limited sample size, we did not consider age-specific growth patterns. Instead, we use age as a control variable which approximates some genetic influences. The constraints imposed by the data forced us to treat diarrhea prevalence as a variable not determined by other variables, and to disregard birth weight.

---

<sup>9</sup> Kielmann et al. (1978b).

The estimation procedure comprised two stages. First, we estimated relationships (5) and (6) to establish whether the household's socioeconomic status affects children's growth and diet. Then, in order to particularize the effect of socioeconomic conditions on growth through the diet, relationships (8) and (9) were estimated. Linear relationships between the outcome variables, nutritional status and diet, and the other variables are assumed. To allow for the nonlinear growth pattern of children, age and age squared were added to the estimated relationships.

The results pertaining to relationship (5) are shown in Table 2. The coefficients on children's age variables indicate the expected nonlinear growth patterns, suggesting diminishing growth increments by age. The coefficients on the sex variable indicate that, on the average, boys are heavier but not necessarily taller than girls. It is evident, however, that the statistical significance of the coefficient on gender is reduced when maternal height is entered in the equation.<sup>10</sup> While we may consider the gender variable as a proxy for genetic factors, this variable can also represent the behavioral discrimination against girls in this particular environment.

---

<sup>10</sup> The zero-order correlation between maternal height and the child being a boy is .31. This correlation is strangely high and apparently represents a selectivity bias in our sample. Mothers of higher socioeconomic classes, who were taller themselves, apparently preferred to have their sons rather than their daughters included in this investigation. This is not apparent in the even sex distribution of the children in our sample, but may indicate a bias in this rather small sample.

As expected, maternal height has a positive effect on child growth. Here again, while this variable approximates the effect of genetic and maternal traits, it apparently also represents other effects. Mother's height is positively correlated with land ownership (.24), and with area of land cultivated (.18). Therefore, when introduced in the equation, this variable also reduced the statistical significance of the socioeconomic variables. Hence, it accounts for some of the longer term, even intergenerational effects, of socioeconomic status on physical growth.

Equations 4 and 5 in Table 2 show that, controlling for all other variables, a higher prevalence of diarrhea appears to have an adverse effect on child growth as measured by height.<sup>11</sup> This particular finding, which was expected, may, in the absence of other data, reflect the harmful effects of bad housing, poor hygienic conditions, and the relative lack of medical intervention for the control of infectious disease on long term nutritional status.

The effects of socioeconomic variables are of key interest to us. These variables are represented interchangeably by father's occupation and by the area of land cultivated by the household. The estimated coefficients indicate that landowners, who are in the highest socioeconomic class in the environment, have the heaviest and tallest children, ceteris paribus. These children are characterized by a better nutritional

---

<sup>11</sup> This finding is significant at a 89% level of a two-tail "t" test.

status than the children of civil servants, artisans, the self-employed, as well as the children of agricultural laborers. Children in the civil servants group appear heavier, but not taller, than the children of laborers.

The use of area of land cultivated as a proxy for family wealth, instead of occupation, (equations 3 and 5 in Table 2), yields the same findings; children whose families cultivate more land are nutritionally superior to children of families which cultivate less land. These results change somewhat in the equations where we control for diarrhea. This change will be discussed later in our study.

The estimated effect of area of land cultivated suggests that, on the average, a 10 percent increase in the amount of available land brings about a 0.5 percent increase in a child's weight and a 0.3 percent increase in his height. Alternatively, an increase of one standard deviation in the area of land cultivated (2.3 acres) is associated with about a 316-gram gain in weight and a 2.3 centimeter gain in height. This implies that an increase in 2.3 acres of land cultivated is associated with an expected drop of about 14 percent in mortality levels in the study population, as a result of improved levels of nutrition.<sup>12</sup>

---

<sup>12</sup> A detailed description of mortality risk associated with various levels of nutrition in this particular study population is in preparation (Kielmann and McCord, 1977).

The results pertaining to relationship (6) are shown in Table 3. As might be expected, older male children of land owners consume more calories than others. Using the area of land cultivated as a proxy for wealth shows that more land cultivated is associated with higher consumption of both calories and calcium; however, this can be demonstrated with statistical significance only for calcium. This particular result indicates that consumption of calcium is more sensitive to household wealth than consumption of calories.

The results thus far provide sufficient basis for concluding that socioeconomic conditions affect children's growth and diet. They do not reveal, however, the particular effect of socioeconomic conditions on child growth through diet; the equations in Tables 2 and 3 estimate the overall effect of socioeconomic status on child growth. In the results shown in Table 2 this effect may operate through other related, but unmeasured variables: for instance, housing and maternal care, which contribute to good health. The estimates in Table 3 may overstate the effect of socioeconomic status on diet because heavier (and taller) children -- who are heavier (and taller) due to better housing and better maternal care -- may have a better appetite than their smaller brothers, and some of this effect is captured by the socioeconomic variables.

To overcome these problems as much as possible, we estimated the simultaneous equations reported in Table 4 pertaining to relationships 7 and 8. The conceptual framework presumes that nutritional status,

measured by weight, for example, and diet, measured by consumption of calories, are codetermined; children who eat more are heavier than children who eat less, and heavier children tend to eat more than lighter children. This relationship is confirmed.

Of special interest to us are the estimates shown in relationship (8). They indicate that for their weight (and age and sex) -- as determined by all other variables -- children of landowners still appear to consume more calories than children of agricultural workers, but this result is not statistically significant. This suggests that when observing two children of equal weight and other measured characteristics, children of landowners have a diet similar to the diet of children of agricultural workers, at least as far as caloric consumption is concerned.

On the other hand, for equal weight and other measurable characteristics, children of the intermediate groups (artisans, self-employed and civil servants) consume fewer calories. Since we know from earlier estimates that these children grow at least as well as those of agricultural laborers, the results imply that children in this middle socioeconomic group grow as well as other children despite a smaller diet. Alternatively, children of parents in the other two groups incur some loss of the diet they consume. This suggests that growth of children in the middle group is more "efficient" vis a vis their diet, due to other factors; these factors apparently are better housing and sanitary conditions, as well as

better parental knowledge on nutrition. This conclusion, which concurs with our field experience and underlies our conceptual framework, cannot be precisely tested with the data available.<sup>13</sup>

##### 5. Conclusion and Implications

While the available data do not permit a full exploration of the analytical framework postulated, the results show a clear link between the socioeconomic environment of pre-school children and their nutritional status.

Children in the highest socioeconomic group have better diets and grow better than children in the middle and low socioeconomic groups. On the other hand, children in the middle group appear able to achieve particular growth levels with smaller diets than children in agricultural groups, landowners, or cultivators. This suggests that parents in the middle group may maintain better sanitary conditions and may be more knowledgeable about child nutrition than parents in specifically agricultural occupations.

---

<sup>13</sup> These results are consistent with the findings on the effects of diarrhea shown in equations 4 and 5 in Table 2. When we control for the adverse effects on growth of diarrhea and compare with equation 3, children of the intermediate and lower socioeconomic groups look alike in terms of height; moreover, land ownership becomes a more significant factor in explaining variation in child growth. These findings imply that in the intermediate group, diarrhea is less prevalent than in the other groups, and that landowners, as opposed to agricultural laborers, may be able to compensate by diet and probably medical care for the higher incidence of disease in their households than in the middle group.

Thus, the children of middle income non-agricultural groups incur a smaller loss of diet due to disease. This conclusion is supported by the estimated adverse effect of diarrhea on child growth among the groups.

For further research, some of this paper's limitations must be acknowledged. Apart from serious constraints imposed by the data available, we should try to expand the analytical framework. The role of birthweight, also as an outcome variable determined by other variables, should be identified and quantified. Furthermore, we should account within this framework for post-natal mortality to eliminate the natural selectivity bias existing in any cross sectional data.

The short-run policy implications of the approach and findings presented in this paper are two-fold: identifying target population and corresponding means of intervention. The lowest socioeconomic group, in the study environment, appears in need of a package including food supplementation and disease control. The highest group appears in need of disease control in particular.

Table 1  
 MEANS, STANDARD DEVIATIONS AND NUMBERS  
 OF VALID OBSERVATIONS OF VARIABLES

Variable	Role in Relationships (8) - (10)	No. of Valid Observations	Mean	Standard Deviation
Weight (kg.)	G	167	9.53	2.20
Height (cm.)	G	66	79.93	7.36
Calories (gm.)	D	173	1066.00	420.00
Calcium (mg.)	D	62	920.00	591.00
Diarrhea Prevalence (Days ill/Days observed)	H	62	0.067	0.25
Age (months)	Z	167	24.67	8.11
Sex (boy = 1) *	Z	167	0.48	.50
Maternal Hgt. (cm.)	Z	62	154.26	4.73
Land Cultivator (yes = 1) *	E	167	0.38	0.49
Civil Servant (yes = 1) * Artisans, etc.	E	167	0.18	0.38
Area of Land Cultivated (hect.)	E	62	2.89	2.26

\* The variable equals zero otherwise.