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CHILDREN'S HEALTH AND THE FAMILY

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ABSTRACT

The objective of this paper is to examine the relationship between a number of family characteristics and the health of white children aged 6 to 11 years residing in those families. The partial effects of family income on health are small and seldom statistically significant. Indeed, some health problems--high blood pressure, allergies, and tension--are more likely to occur among children from high income families. The general finding of small partial income effects is supported by analysis of gross health differences between children from lower and higher income families. In those cases where significant gross health differences do exist between children from these two income classes, decomposition of these gross differences shows them to be attributable in large part to factors other than income itself. The finding that differences in health related solely to income are smaller than commonly believed implies that policies to improve the well-being of children via income transfers, such as those advocated by the recent Carnegie Council on Children, would have, at best, very small effects on health. Indeed, the most important conclusion of our study is that the present tendency to base government child health programs on simplistic notions that income is the primary source of differences in children's health will not lead towards fruitful or successful public policy regarding children's health.

Among the other family characteristics studied, our most interesting results are for parents' schooling, mother's labor force status, and family size. Parents' schooling is an important determinant of children's health. In most instances children of well educated parents are in better health than those of less well educated parents. In fact, for four of the five health measures that have a significant gross correlation with income, much of this observed income difference is accounted for by associated differences in parents' schooling. The mother's labor force status and family size have small health effects and are strongly related only to the health variables representing the child's nutritional status (height, weight, and the periodontal index). Children whose mothers are in the labor force or who come from larger families are likely to score more poorly with respect to these nutritional measures. These results are important in the light of the striking upward trend in the labor force participation rate of married women with children and the striking downward trend in family size in the United States.

Finally, the frequency with which the child received dental care has large and significant impacts for most of the health measures. This finding is important because the dental care variable serves as a proxy of the price and availability of preventive medical care. If it can be replicated with more direct measures of preventive care, then policies directed at either improving the availability of medical care or altering public attitudes towards preventive care could have large health payoffs for children.

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I. Introduction

Children's health care has been and continues to be provided primarily within the family. This is in marked contrast to the provision of children's education which for the past 100 years has been considered a legitimate concern of government [see Landes and Solmon (1)]. While no one believes that the government can replace the family in providing education for children, state governments do determine how many years children must attend school, how many days per year they must attend, and, to a large extent, the content of that schooling. Further, recent rulings of the Supreme Court stipulate that all children are entitled to schooling of equal quality. Only recently has attention turned to the role of the preschool years, and consequently, the family, in determining the intellectual development of children.[1]

In the case of children's health, it has been widely recognized that it is the family rather than the public or medical care sectors that plays the fundamental role. For example, a recent Carnegie Council on Children report says "Doctors do not provide the bulk of health care for children; families do" [Keniston (3), p. 179]. With the exception of immunization, which clearly has important externalities, there has been no form of compulsory health care for children,[2] and with the advent of relatively simple and effective treatments for important childhood diseases of the past (influenza, pneumonia, and tuberculosis), one might even imagine that the doctor's role is declining. Indeed, the expanding interest of pediatricians into the area of the "new morbidity"--"learning difficulties and school problems, behavioral disturbances, allergies, speech difficulties, visual problems, and the problems of adolescents in coping and adjusting"--is a response to the decline in importance of the traditional health problems of children.[3]

While the overall importance of the family in providing health care for children is widely acknowledged, information about the nature of the association between various family characteristics and the health status of children is relatively scarce. Much of the literature concentrates on two infant health measures--infant mortality and birth weight--and documents that infants from both black families and low income families experience a higher incidence of mortality and low birth weight [Keniston (3), p. 156]. When the health of children who survive the first year of life is the subject of study, much less is known; and again, existing studies focus primarily on health differences associated with income and race.[4] For example, there is evidence that both black families and low income families evaluate their children's health as poorer than do white or high income families. Similarly, children from black or low income families are reported to exhibit a higher incidence of "significant abnormalities" on a physical exam.[5] The extent to which these documented differences are the result of income and/or race alone, as opposed to correlated factors like parental education, family size, mother's work status, and place of residence, has hardly been studied. In order to formulate sensible and effective programs to improve the health of children, we need a much better understanding of how these and other family characteristics work in producing healthy children. Our study is a step in this direction.

More specifically, the objective of this paper is to examine the relationship between a number of family characteristics and the health of children aged 6 to 11 years residing in those families. This multivariate analysis is carried out within the framework of an economic model of the family. Such a framework explicitly recognizes not only the family's function as health care provider, but also that it is faced with resource constraints and that some of its objectives for its children may conflict with maximizing their health level.

The data set used, Cycle II of the Health Examination Survey, is an exceptional source of information about a national sample of 7,119 noninstitutionalized children aged 6 to 11 years in the 1963-65 period.[6] The data comprise complete medical and developmental histories of each child provided by the parent, information on family socioeconomic characteristics, birth certificate information, and a school report with data on school performance and classroom behavior provided by teachers or other school officials. Most important, there are objective measures of health from detailed physical examinations. The physical examinations (as well as associated psychological and achievement tests) were administered by the Public Health Service. There is little direct information about the medical care received by these children, but some attempt will be made to control for variations in the availability of local medical care.

The amount of health information for the children in the Cycle II sample is prodigious. To illustrate the exact nature of this information and to provide a description of the overall health of the children in the sample, selected summary data are presented in Table I. Panel A indicates that almost 95 percent of parents rate their child's health as good or very good. At the same time, however, 19 percent of these parents consider their child's present health to be a problem. The Public Health Service physicians affirm the latter assessment in the sense that they find that 11.2 percent of the children had at least one "significant abnormality" (see Panel B). An

TABLE I

Summary of Selected Health Information from Cycle II of the Health Examination Survey[a]

Panel A. Parent's Assessment of Children's Current Health

	Percent of Children Whose Parent Rates Present Health as:				Percent of Children Whose Parent Considers Present Health a Problem
	Very Good	Good	Fair	Poor	
Both sexes	51.8	42.9	4.9	.4	19.0
Boys	51.6	43.2	4.8	.4	19.0
Girls	51.8	42.7	5.1	.4	19.0

Panel B. Physician's Findings on Survey Examination

	Percent of Children with Finding of		Distribution of Those with Significant Abnormality by Type of Abnormality (Percent)				
	Otitis Media	Significant Abnormality	Cardio-vascular	Injury Residual	Neuro-muscular Joint	Other Congenital	Other Major Diseases
Both sexes	1.6	11.2	22.9	13.7	31.8	23.6	28.6
Boys	1.8	12.2	21.8	13.5	32.9	22.6	28.9
Girls	1.4	10.2	24.4	14.1	30.4	24.7	28.1

(continued on next page)

TABLE I (concluded)

Panel C. Medical History as Reported by Parent

Medical History Item	Both Sexes	Boys	Girls
(percent of children with history of indicated condition)			
Accidents			
Broken bones	7.8	8.5	7.0
Knocked unconscious	3.4	4.0	2.8
Scars from burns	4.5	4.4	4.7
Other accidents	4.2	4.7	3.7
Allergies and Related Conditions			
Asthma	5.3	6.5	4.0
Hay fever	4.6	5.5	3.6
Other allergies	11.4	12.2	10.7
Kidney condition	3.9	2.6	5.1
Heart condition	3.7	4.2	3.1
Sensory-Neurological Conditions			
Convulsions or fits	3.3	3.5	3.1
Eye trouble	14.0	12.7	15.3
Trouble hearing	4.3	4.8	3.7
Earaches	26.8	24.8	28.8
Running ears	11.9	12.2	11.6
Problem talking	8.4	10.0	6.8
Trouble walking	2.3	2.5	2.1
Arm or leg limitation	1.3	1.3	1.2
Operations	30.8	35.3	26.1
Hospitalized more than 1 day	26.8	30.0	23.6
Exercise Restricted			
Ever	5.4	5.6	5.2
Now	1.5	1.4	1.6
Taking medicine regularly	4.1	4.0	4.2

[a]Source: NCHS (11)
Panel A - Table 1
Panel B - Tables 1 and 3
Panel C - Table 4

indication of the types of problems that may be bothering parents is given by the incidence of various items in the medical history (Panel C). The total picture, then, is of a cohort whose overall health is good but who are nevertheless disturbed by particular health problems.

The paper proceeds as follows. Section II briefly describes the economic model of the family used to generate the relationships to be estimated. Section III discusses the nature of the estimated relationships and defines the variable measures. The estimates are presented and discussed in Section IV. The final sections highlight and interpret the statistical findings of the study.

II. The Economist's View of Children and Children's Health

An important focal point of recent economic models of fertility [Becker and Lewis (14); Willis (15); Ben Porath and Welch (16)] is that children are not homogeneous. In particular, these models distinguish between two aspects of children that enter the parents' consumption (or investment) portfolio-- the number of children and the "quality" of each child. By quality of the child is meant those characteristics of the child which generate utility (or disutility) for the parents: his health, sex, wealth, social adjustment, intellectual development, sense of humor, etc. Therefore, when parents choose their optimal family composition, they choose not only how many children they will have, but also what portion of the family's resources will be devoted to each child.[7] This choice is made in the usual way: parents choose the number and quality of children, as well as of other consumption goods, so as to maximize their utility subject to the constraints imposed by their wealth (their potential earned income and their nonearned income) and the various prices they face. In the case of children, there is a further constraint in the form of children's genetic endowments which in part determine their quality. Genetic endowments act as a constraint because they are, for the most part, outside of the family's control.[8]

The prices of children and of the various components of their quality are determined by recognizing that children are produced within the home using goods bought in the market and the time of family members. The cost of producing a child of a given quality depends on the prices of the purchased inputs--parents' time, medical care, food, toys, lodging, etc.--and on the efficiency with which these inputs are used. The marginal cost of a child, then, depends on the quality chosen and on the cost of one unit of that amount of quality. Similarly, the cost of an increment in quality depends on how many children will receive this increment (i.e. family size) and on the cost of an incremental unit of quality.[9] To take the case of the aspect of child quality focused on in this paper, children's health, the cost (price) of increasing the average health level of all children in the family depends on the number of children in the family and on the costs of medical care, nutrition, the parents' or other caretakers' time, and any other purchased inputs used to improve children's health. In addition, to the extent that there are systematic differences in the ability of families to produce children's health with given inputs, these differences in efficiency are also relevant. For example, more educated parents are more likely to be able to follow doctors instructions, to have general information about nutrition, and to be willing and able to acquire medical information from published materials. Consequently, one would expect more educated parents to be more efficient at producing healthy children.

Given these considerations, the following factors are expected to influence children's health levels: the child's exogenous (genetic) health endowment, family wealth, parents' wage rates, family size, parents' educational attainment and other measures of their efficiency in household production, costs and availability of medical care and of other market health inputs (vitamins, sanitation, etc.), the prices of inputs used to produce other aspects of child quality, and the prices of other forms of parents' consumption. The relationship between the child's ultimate health and these factors may be termed a demand function for the output health.[10] In this demand function a positive association between children's health and family wealth is predicted (assuming that child health is a normal good). Similarly, a positive association is expected between both parents' education and children's endowed health status and children's ultimate health status.[11] Negative associations would be anticipated between all of the prices of health inputs and children's health, and between family size and children's health. Parents' wage rates may have negative or positive effects on children's health levels, depending on whether the household production of children's health is more or less time intensive than the production of other aspects of child quality and/or other types of parents' consumption commodities. Finally, to the extent that there is substitutability between the various aspects of child quality, the prices of inputs into the non-health aspects of child quality (say, music lessons) might be positively associated with children's health.[12]

These predictions concerning the effects of various family characteristics and market prices do not necessarily apply when some realistic twists are incorporated into the model. An important instance is the introduction of joint production between various aspects of child quality and/or between child quality and other consumption commodities. Such joint production can make both wealth effects and input price effects ambiguous. To take a simple example, both athletic development and health may be regarded as aspects of children's quality. If athletic development has a high income elasticity and also has some negative health effects, a negative relationship between income or wealth and certain health measures may be observed. Indeed, the incidence of broken bones is greater in high income families than it is in low income families [NCHS (11), Table 14]. Alternatively, suppose that parents' time in child care yields direct utility rather than generating utility only through its effect on children's quality. In this case, parents may appear to choose inefficient modes of producing child quality, modes that use "too much" time relative to its cost.

The basic model outlined above is also modified when one takes account of the fact that the human capital dimensions of child quality are by necessity embodied in the child. Because of this embodiment, for some types of human capital there are natural minimum and maximum states that cannot be reduced or exceeded. In the case of children's health, increased expenditures on health inputs or increased production efficiency cannot continually increase the child's health. For this reason, one would not predict constant absolute effects of the various determinants of children's health but rather that these effects attenuate in the region of minimum and maximum health levels.

Recent models of intergenerational transfers utilize this embodiment insight in a somewhat different way. In these models investments in children's human capital are assumed to be subject to decreasing returns in terms of the future earnings of the child. This assumption, along with the assumption that parents measure a child's quality by his expected lifetime wealth, generates additional predictions concerning the effects of the set of variables discussed earlier on various components of children's quality.[13] In particular, this type of model yields a distinction between two types of families: those for whom the optimal quantity-quality calculation involves making a financial transfer to their children and those for whom such a financial transfer is not optimal. These two types of families differ systematically with respect to the effects of the various explanatory variables on the human capital dimensions of child quality. The strongest prediction is that the wealth effect on the child's human capital (health, in our case) will be zero in families which plan to make financial transfers to the children, but positive in families who do not plan such a transfer [see Edwards and Grossman (17)].

What is striking about this review of the economic models is that although they differ in many respects, they all designate the same set of factors as determinants of children's health--parents' wealth, wage rates, and education, family size, other input prices, etc. In addition, they provide ready structures within which to interpret empirical findings. Thus, the greater incidence of broken bones among children from high income families is seen not as an anomalous finding but rather as a result of conflicting family objectives concerning various aspects of child quality. Or, a finding that for high income families increases in wealth are not associated with increased children's health is not viewed as evidence that wealthy parents do not care about their children but rather as a result of the fact that wealthy parents have already made the optimal health investment for their children. In the sections to follow, both the choice of variables to be investigated and the interpretation of the results of that investigation are guided by the general framework outlined here.

III. Variables and Relationships to be Estimated

A. Measurement of Child Health

The issue of defining and measuring children's health is very much an unresolved one, even among professionals in the area of public health.[14] The economist's approach is to define health as a form of human capital which determines the amount of time available for consumption and for work in the home and labor market.[15] (Individuals may also derive disutility, or even utility, from the state of being ill.) With this type of definition, an appropriate measure of health status over some time period would be the proportion of potential time that is actually available for the usual consumption, maintenance, and work activities. Similarly, the complementary measure of ill health would be the proportion of potential available time lost due to inability to function or to imperfect functioning. While such disability may seem to be relatively easy to measure when dealing with adults who are members of the labor force (a good approximation is days lost from work because of illness), it is not easy to measure for other adults. Moreover, even a measure of days lost from work might not capture losses in consumption time. Therefore, in economists' studies of adults' health, both the incidence of particular physical conditions and the individual's own assessment of his health status have been used as supplementary health measures [Grossman (25)].

We use the same type of restricted, morbidity-oriented, definition of children's health--focusing on the child's physical health rather than his overall well being--and similar types of measures--disability, physical conditions, and parental assessment of health status. The use, however, of disability measures (time lost from usual activities) and of the incidence of certain physical conditions is somewhat less appropriate for children than for adults.[16] This is because there is a natural sequence of childhood diseases and acute conditions which prevent children from carrying out their normal activities, but which do not reflect the child's health capital or the child's future prospects for life preservation and normal functioning. A useful distinction to make here is between "permanent" health, which is what we mean by health capital, and "transitory" health, those short-run deviations from one's normal state of health caused by the acute conditions of childhood.[17] It is the child's "permanent" health status that we wish to study, and we attempt to use those health measures which will be good predictors of that "permanent" health status.[18]

In some situations a single overall index of "permanent" health might be desired--to describe parsimoniously the health status of a population, or to allocate public funds. Health, however, clearly is a multidimensional concept. Analysis of a set of components rather than a single index allows us to detect differences in the effects of family background variables on the various dimensions of health. Such analysis also avoids an essentially arbitrary weighting of the various dimensions of health implied by a health index.[19]

The actual choice of components of children's health status to be examined is controlled by the Cycle II data set and guided by the child health literature,[20] as well as by discussions with public health pediatricians.[21] The measures are listed and described below.

1. The parent's assessment of the child's overall current health, represented by PFGHEALTH. PFGHEALTH is a dichotomous variable indicating whether the parent views the child's health as poor, fair, or good (as opposed to very good).

2. Current height and weight, represented by IHEIGHT and IWEIGHT. These are standard indicators of children's nutritional status [for example, National Center for Health Statistics (33) and (34); Seoane and Latham (35)], and good nutrition is an obvious and natural vehicle for maintaining children's health. Height is a better summary measure of the lifetime nutritional status of the child, while weight conveys information primarily about his or her current nutritional status. Since it is well known that physical growth rates differ by age and sex, our height variable is computed as the difference between the child's actual height and the mean height for his or her age-sex group divided by the standard deviation of height for that age-sex group. Our weight measure is computed in a similar manner.[22]

3. The child's hearing acuity, represented by IHEAR. IHEAR is a dichotomous variable indicating whether the child has abnormal hearing. A child is defined to have abnormal hearing if the average threshold decibel reading in his best ear over the range of 500, 1,000, and 2,000 cycles per second (c.p.s.) is greater than 15. 500, 1,000, and 2,000 c.p.s. are the frequencies that occur most frequently in normal speech. A threshold of 15 or more decibels above audiometric zero at these frequencies is classified as corresponding to "significant difficulty with faint speech" by the Committee on Conservation of Hearing of the American Academy of Ophthalmology and Otolaryngology [NCHS (36)].

4. The child's visual acuity, represented by the dichotomous variable ABVIS. ABVIS indicates if the child has abnormal distance vision. All children were examined <u>without</u> their eyeglasses; their uncorrected binocular distance vision is defined as abnormal if it is worse than 20/30 [NCHS (37)].[23]

5. The child's blood pressure, represented by HDBP. HDBP is a dummy variable which indicates if the child's diastolic blood pressure exceeds the 95th percentile for his or her age and sex.

6. Whether or not the child has hayfever or other allergies, represented by the dummy variable ALLEG.

7. An assessment of the child's level of tension, represented by the dummy variable TENS. TENS characterizes children who are rated by their parents as "high strung" or "moderately tense." Both the tension and allergy variables may be regarded as measures of the "new morbidity."

8. The presence of one or more "significant acquired abnormalities" on physical examination of the child, represented by the dummy variable ACABN. These abnormalities include heart disease; neurological, muscular, or joint conditions; and other major diseases.[24]

9. The child's periodontal index, represented by APERI. APERI is a good overall indicator of oral health as well as a positive correlate of nutrition [Russell (38)]. Due to the significant age and sex trends in this variable, it is standardized by age and sex in the same manner as height and weight. Higher values of APERI denote poorer values of oral health.[25]

10. Excessive absence from school for health reasons during the past six months, represented by the dichotomous variable SCHABS. This variable is taken from information provided by the child's school.[26]

Precise definitions of the above health measures appear in Table II, along with their sample means and a notation concerning the source of each variable (medical history, physician's exam, birth certificate, or school form).

TABLE II
Definitions of Health Measures

Variable Name	Mean in Sample[a]	Definition	Source[b]
PFGHEALTH	.451	Dummy variable that equals one if parental assessment of child's health is poor, fair, or good and zero if assessment is very good	1
IHEIGHT	.071[c]	Height, standardized by the mean and standard deviation of one-year age-sex cohorts	3
IWEIGHT	.042[c]	Weight, standardized by the mean and standard deviation of one-year age-sex cohorts	3
IHEAR	.006	Dummy variable that equals one if hearing is abnormal	3
ABVIS	.116	Dummy variable that equals one if uncorrected binocular distance vision is abnormal	3
HDBP	.054	Dummy variable that equals one if the child's diastolic blood pressure is above the 95th percentile for his age and sex	3
ALLEG	.156	Dummy variable that equals one if the child has had hayfever or any other kind of allergy	1
TENS	.476	Dummy variable that equals one if the parent rates the child as high strung or moderately tense	1
ACABN	.037	Dummy variable that equals one if the physician finds a "significant" acquired abnormality in examining the child (other than an abnormality resulting from an accident or injury)	3
APERI	-.034[c]	Periodontal index, standardized by the mean and standard deviation of one-year age-sex cohorts	3
SCHABS	.045[d]	Dummy variable that equals one if child has been excessively absent from school for health reasons during the past six months	4

(footnotes on next page)

Footnotes to TABLE II

[a]These means are computed for the "basic" sample of 4,196 white children described in Section IV.

[b]The sources are 1 = medical history form completed by parent, 2 = birth certificate, 3 = physical examination, 4 = school form completed by teacher or other school official.

[c]The mean of this variable is not zero because standardization was done using the entire Cycle II sample rather than the subsample reported on in this paper.

[d]The mean of this variable is computed for a subsample of 3,812 for whom the school report is not missing.

B. Measurement of Explanatory Variables

The theoretical variables needed for investigating children's health were listed earlier: family wealth, parents' wage rates, parents' educational attainment (or other measures of their efficiency in household production), the child's health endowment, the costs and availability of medical care and other market health inputs, the prices of other inputs used to produce child quality, the prices of other forms of parents' consumption, and family size.

Not surprisingly, the actual measures available in the Cycle II survey correspond only roughly to the above theoretical variables. We discuss these measures and indicate how they relate to the theoretical variables below. A complete list of the measures, their precise definitions, and their sample means and standard deviations appear in Table III.

Family wealth and the father's wage rate are both represented by the family income measure. Two income variables are used (FINC, HFINC) in order to allow for the possibility that the relationship between family wealth and children's health differs for high and low income families.[27]

The mother's wage rate is not directly available in the survey. We attempt to control for variations in her wage rate with three variables: her educational attainment (MEDUCAT) and two measures of her current work status (MWORKFT, MWORKPT). More educated women are more likely to have higher opportunity costs, as are women who are currently in the labor force.

As efficiency (or taste) measures we use mother's and father's educational attainment (MEDUCAT, FEDUCAT) and a dummy variable identifying

TABLE III
Explanatory Variables

Variable Name	Sample Mean[a]	Sample Standard Deviation[a]	Definition[b]
FINC	7.502	4.405	Continuous family income computed by assigning midpoints to the following closed income intervals, $250 to the lowest interval, and $20,000 to the highest interval. The closed income classes are: $500 - $999 $1,000 - $1,999 $2,000 - $2,999 $3,000 - $3,999 $4,000 - $4,999 $5,000 - $6,999 $7,000 - $9,999 $10,000 - $14,999
HFINC	5.038	6.138	Same as FINC for income of $7,000 and over; equals zero for incomes below $7,000
MWORKPT MWORKFT	.132 .158	.339 .365	Dummy variables that equal one if the mother works part-time or full-time, respectively
MEDUCAT	11.095	2.808	Years of formal schooling completed by mother
FEDUCAT[c]	11.220	3.461	Years of formal schooling completed by father
FLANG	.105	.307	Dummy variable that equals one when a foreign language is spoken in the home
LIGHT1	.013	.112	Dummy variable that equals one if child's birth weight was under 2,000 grams (under 4.4 pounds)
LIGHT2	.043	.202	Dummy variable that equals one if child's birth weight was equal to or greater than 2,000 grams but under 2,500 grams (under 5.5 pounds)
CABN	.050	.219	Dummy variable that equals one if the physician finds a "significant" congenital abnormality in examining the child

TABLE III (concluded)

Variable Name	Sample Mean[a]	Sample Standard Deviation[a]	Definition[b]
MALE	.513	.500	Dummy variable that equals one if child is male
LMAG	.073	.261	Dummy variable that equals one if the mother was less than 20 years old at birth of child
HMAG	.105	.307	Dummy variable that equals one if the mother was more than 35 years old at birth of child
FIRST	.288	.453	Dummy variable that equals one if child is the first born in the family
TWIN	.023	.149	Dummy variable that equals one if child is a twin
NEAST MWEST SOUTH	.236 .322 .181	.425 .467 .385	Dummy variables that equal one if child lives in Northeast, Midwest, or South, respectively; omitted class is residence in West
URB1 URB2 URB3 NURB	.199 .120 .181 .148	.400 .325 .385 .355	Dummy variables that equal one if child lives in an urban area with a population of 3 million or more (URB1); in an area with a population between 1 million and 3 million (URB2); in an urban area with a population less than 1 million (URB3); or in a non-rural and non-urbanized area (NURB); omitted class is residence in a rural area
DENT12	.169	.375	Dummy variable that equals one if child has been to a dentist sometime in his life but not within the last twelve months
DENTIST3	.179	.383	Dummy variable that equals one if child has never been to a dentist
LESS20	3.635	1.676	Number of persons in the household 20 years of age or less
NOFATH	.071	.257	Dummy variable that equals one if child lives with mother only

Footnotes to TABLE III

[a]These means and standard deviations are computed for the "basic" sample of 4,196 children described in Section IV.

[b]All of these variables except LIGHT1, LIGHT2, and CABN are taken from the medical history form. LIGHT1 and LIGHT2 come from the child's birth certificate, and CABN, from the physical examination.

[c]For children who were not currently living with their father, father's education was coded at the mean of the sample for which father's education was reported.

mothers who were under 20 years-old at the time of the child's birth (LMAG). Young mothers are notoriously less efficient at contracepting and may be similarly less efficient in producing healthy children. A supplementary efficiency (or taste) measure is a variable indicating whether a foreign language is spoken in the home (FLANG). Foreign born families are likely to exhibit differences in tastes and/or household production efficiency.

The child's endowed health status is represented by a set of variables relating to his early health. They are dummy variables identifying children of low birth weight (LIGHT1, LIGHT2), children with congenital abnormalities (CABN), the child's sex (MALE), and children whose mothers were over 35 years-old at the time of the child's birth (HMAG). Low birth weight is a typical indicator of a less healthy birth outcome.[28] The rationale for including a variable identifying older mothers is that older mothers are more likely to bear children with health defects. The child's sex is included because of the well documented higher incidence rates of certain health problems among males at young ages [for example, NCHS (11)].

In addition to these health endowment measures, we also control for several characteristics of the child which are not necessarily health related but may cause him to receive better or worse treatment within the family simply by virtue of his luck in possessing these characteristics. They are his birth-order (FIRST), whether or not he is a twin (TWIN), as well as his sex (MALE). First born children (or non-twins) will have greater access to individual parental attention because they arrived in the family first (or they arrived alone). Similarly, male children may receive larger investments than female children if males are preferred [see Ben Porath and Welch (16)].

Direct information about the prices of inputs in the health production function and in the other household production functions is not available in the Cycle II data. Moreover since the precise locality of each observation cannot be identified at the present time,[29] it is not possible to estimate these prices with local market data. Therefore to partially control for these prices, we use a set of three region and four size of place of residence variables. (These variables will also control for other regional differences that are not otherwise accounted for.) In addition, information about the last time the child visited a dentist (DENT12 and DENTIST3) is used to provide a somewhat more specific index of the price and availability of medical care. The latter variables not only proxy the price and availability of medical care in the area but also the family's preferences and attitudes concerning preventive care.[30]

Finally, family size is represented by the number of people in the family who are under 20 years of age at the time of the Cycle II interview (LESS20). LESS20 may therefore overstate or understate actual completed family size.

In surveying these variables, it is immediately obvious that some of them are not the exogenous measures called for by the theory but rather are proxies that are in part endogenously determined. That is, some of these variables not only represent exogenous prices or endowments but are themselves outcomes of the family's decision making. For example, mother's labor force status represents her wage rate as well as the amount of time she chooses to spend with her children. Similarly, some of the health endowment measures--birth weight, mother's age at the time of the child's birth, and whether or not congenital abnormalities are present--reflect not only genetic endowments but also family choices regarding prenatal care and the timing of childbearing, both of which condition the birth outcome. The same observation can be made about the measures used to proxy the price and availability of medical care (DENT12 and DENTIST3). They represent both exogenous prices and endogenous health inputs.

One other explanatory variable is endogenous--family size--but for a different reason. Family size is endogenous not because it is an imperfect proxy for a truly exogenous variable, but because in the theoretical model both family size and children's health are simultaneously determined.[31]

The endogeneity of family size as well as the other variables mentioned above poses the usual problem of bias in their coefficient estimates unless appropriate simultaneous estimation techniques are used. Such techniques cannot be used in this case, however, because appropriate data are not available, and even if they were, the coefficients are not always identifiable.[32] As an alternative procedure, we estimate the children's health equations two ways, both with and without the set of endogenous variables included. When they are excluded, the coefficients of the various exogenous family characteristics will reflect their gross impacts. Estimates with the endogenous input, endowment, and family size variables included will reveal to what extent the exogenous family characteristics operate through these endogenous measures.

To recapitulate, the equations we estimate have the health variables listed in Table II as dependent variables and the variables listed in Table III as explanatory variables. These equations are not pure reduced-form demand equations for children's health for two reasons. First, the inclusion of family size, an endogenous variable from the structural demand equation, makes the estimating equation a hybrid of a reduced form and structural demand equation. Second, measures of some of the relevant theoretical variables are unavailable and the proxy measures used also represent endogenous input quantities. The final estimating equation reported on here, then, is a mixture of a structural demand equation, a reduced form demand equation, and a production function. Interpretation of our results will allow for the hybrid nature of these equations.

IV. Empirical Results

The equations described in the previous section are estimated using data for white children who live with either both of their parents or with their mothers only. There were 5,768 such children in the Cycle II sample. The exclusion of children for whom there were missing data brings the final sample to 4,196.[33] Data for both types of family composition are pooled for analysis because preliminary estimates indicated that there were no significant differences in the sets of slope coefficients for all dependent variables except SCHABS. A dummy variable identifying children who live with their mothers only (NOFATH) is included to allow for differences in children's health that may be uniquely associated with the absence of a father. We do not use data for black children in estimating the equations because preliminary analysis revealed significant race differences in slope coefficients for about half of our health measures. In addition, since the black sample is too small to allow for reliable coefficient estimates, separate estimates for black children are not presented.

The method of estimation is ordinary least squares. Although this is not the optimal econometric procedure to use when the dependent variable is dichotomous, use of LOGIT[35] or another appropriate nonlinear estimation procedure is not feasible given the sample size and number of variables in our empirical work. To determine whether this misspecification is likely to greatly affect our results, we experimented with alternative estimation procedures on a subsample of one-third of our basic sample. Using a dependent variables with a low incidence and one with an incidence near .5, we obtained both OLS and LOGIT estimates of our equations for this subsample. In both cases the differences between alternate estimators are small: OLS coefficients and the analogous marginal effects in LOGIT are of similar magnitudes and signs, and the patterns of statistical significance do not alter. Indeed, the differences between these OLS and LOGIT estimates for the one-third subsample are much less than are the differences between OLS estimates for the full sample and for the one-third subsample. On the basis of these experiments we believe that OLS estimation applied to the full sample provides the more accurate picture of the relationship between measures of health and the various explanatory variables. Of course, the usual statistical tests on a single coefficient or on sets of coefficients can only be interpreted as suggestive when the dependent variable is dichotomous because the assumptions underlying these tests are not satisfied.

We organize our discussion of the results around groups of explanatory variables. Therefore, rather than presenting estimates of the equations in a single massive table, we have chosen to partition the results into several tables, each showing the coefficients of a subset of explanatory variables.

It should be emphasized, however, that the coefficients in each of these tables are taken from multiple regression estimates that contain either the complete set of explanatory variables in Table III or that subset we have classified as exogenous.

A. Overview

The obvious first question to ask is are these health measures amenable to statistical explanation with the set of variables considered here? To answer this question we present adjusted R^2's and "F" statistics for the health equations both with and without the set of endogenous explanatory variables (Table IV). In all cases except for hearing acuity and excessive school absence the equations are statistically significant at the 1 percent level of significance in one or both formulations. Further, only for the hearing variable are none of the individual explanatory variables ever statistically significant. Thus, we can conclude that for most of the health measures we study, observed variations in our sample are not caused solely by chance but rather are systematically related to the set of family, endowment, and region and city size characteristics considered here.

B. Exogenous Family Characteristics

Since the prime focus of this paper is the relationship between family characteristics and children's health, we begin by looking at the measures of exogenous family characteristics--income, parents' education, whether or not a father lives with the family, and whether or not a foreign language is spoken in the home. The coefficients of these variables appear in Table V (the results for IHEAR are not shown in this and

TABLE IV
Adjusted R Squares and F Statistics

	Equation 1[a]		Equation 2[b]	
Dependent Variable	Adjusted R Squared	F Statistic	Adjusted R Squared	F Statistic
PFGHEALTH	.073	(21.71*)	.083	(15.61*)
IHEAR	-.001	(0.73)	-.002	(0.65)
ABVIS	.005	(2.26*)	.006	(1.99*)
HDBP	.006	(2.79*)	.007	(2.25*)
ALLEG	.032	(9.69*)	.037	(7.15*)
TENS	.020	(6.32*)	.020	(4.35*)
ACABN	.002	(1.62)	.006	(1.89*)
SCHABS	.001	(1.34)	.002	(1.22)
IHEIGHT	.040	(12.63*)	.071	(13.75*)
IWEIGHT	.030	(9.60*)	.060	(11.72*)
APERI	.104	(33.50*)	.109	(21.55*)

*Statistically significant at the 1 percent level of significance.

[a]Explanatory variables are FINC, HFINC, FEDUCAT, MEDUCAT, FLANG, NOFATH, MALE (when relevant), FIRST, TWIN, NEAST, MWEST, SOUTH, URB1, URB2, URB3 and NURB.

[b]Explanatory variables include those in equation 1 plus LESS20, LIGHT1, LIGHT2, CABN, MWORKPT, MWORKFT, LMAG, HMAG, DENT12 and DENTIST3.

TABLE V
Coefficients of Exogenous Family and Child Characteristics*
("F" statistics in parentheses)

Explanatory Variable	PFGHEALTH Eq. (1)	PFGHEALTH Eq. (2)	ABVIS Eq. (1)	ABVIS Eq. (2)	HDBP Eq. (1)	HDBP Eq. (2)	ALLEG Eq. (1)	ALLEG Eq. (2)	TENS Eq. (1)	TENS Eq. (2)
FINC	-.0121 (5.75)	-.0115 (5.17)	-.0028 (0.70)	-.0035 (1.06)	.0026 (1.17)	.0023 (0.92)	.0022 (0.34)	.0008 (0.04)	.0011 (0.04)	.0013 (0.06)
HFINC	-.0005 (0.02)	-.00004 (0.00)	.0033 (2.06)	.0035 (2.26)	-.0015 (0.85)	-.0016 (0.99)	.0003 (0.01)	.0005 (0.04)	-.0021 (0.35)	-.0024 (0.47)
FEDUCAT	-.0139 (19.68)	-.0118 (14.14)	.0038 (3.32)	.0037 (3.12)	-.0031 (4.50)	-.0031 (4.49)	.0059 (6.44)	.0053 (5.14)	-.0032 (0.96)	-.0035 (1.14)
MEDUCAT	-.0110 (9.21)	-.0080 (4.65)	-.0036 (2.21)	-.0046 (3.40)	-.0022 (1.70)	-.0029 (2.73)	.0100 (13.87)	.0072 (6.66)	.0061 (2.71)	.0068 (3.07)
FLANG	-.0048 (0.04)	-.0121 (0.22)	-.0127 (0.55)	-.0121 (0.49)	-.0136 (1.27)	-.0139 (1.31)	-.0179 (0.88)	-.0150 (0.61)	-.0734 (7.66)	-.0739 (7.72)
NOFATH	-.0019 (0.004)	-.0179 (0.33)	-.0231 (1.30)	-.0277 (1.78)	-.0238 (2.77)	-.0253 (2.97)	-.0124 (0.30)	-.0167 (0.52)	-.0291 (0.86)	-.0208 (0.42)
FIRST	-.0544 (10.86)	-.0342 (3.51)	.0110 (1.00)	.0054 (0.20)	.0090 (1.35)	.0086 (0.99)	.0426 (12.01)	.0247 (3.28)	.1240 (52.98)	.1266 (44.68)
TWIN	.0035 (0.01)	-.0262 (0.26)	.0407 (1.49)	.0396 (1.33)	-.0218 (0.86)	-.0269 (1.24)	-.0982 (6.95)	-.0881 (5.32)	.0177 (0.12)	-.0062 (0.01)
MALE	-.0014 (0.01)	-.0024 (0.03)	-.0250 (6.39)	-.0251 (6.38)	- -	- -	.0324 (8.60)	.0336 (9.24)	.0568 (13.75)	.0573 (13.96)

(continued on next page)

TABLE V (concluded)

Explanatory Variable	ACABN Eq. (1)	ACABN Eq. (2)	SCHABS Eq. (1)	SCHABS Eq. (2)	IHEIGHT Eq. (1)	IHEIGHT Eq. (2)	IWEIGHT Eq. (1)	IWEIGHT Eq. (2)	APERI Eq. (1)	APERI Eq. (2)
FINC	.0020 (1.03)	.0020 (0.99)	.0043 (3.52)	.0044 (3.77)	.0040 (0.16)	.0006 (0.004)	.0237 (5.27)	.0191 (3.50)	-.0175 (5.37)	-.0167 (4.89)
HFINC	-.0019 (1.97)	-.0018 (1.79)	-.0036 (5.30)	-.0036 (5.41)	.0077 (1.26)	.0069 (1.05)	-.0080 (1.29)	-.0075 (1.16)	.0045 (0.77)	.0047 (0.82)
FEDUCAT	.0016 (1.74)	.0020 (2.67)	.0011 (0.55)	.0013 (0.80)	.0155 (6.16)	.0113 (3.32)	.0073 (1.31)	.0060 (0.90)	-.0241 (26.57)	-.0209 (19.61)
MEDUCAT	-.0007 (0.24)	-.0004 (0.08)	-.0023 (1.89)	-.0017 (0.96)	.0257 (12.75)	.0134 (3.37)	.0152 (4.21)	.0033 (0.20)	-.0218 (16.24)	-.0177 (10.07)
FLANG	.0254 (6.41)	.0233 (5.37)	-.0122 (1.11)	-.0138 (1.41)	-.0666 (1.69)	-.0584 (1.33)	.0279 (0.28)	.0287 (0.31)	-.0099 (0.07)	-.0159 (0.17)
NOFATH	-.0212 (3.18)	-.0263 (4.70)	.0285 (4.26)	.0281 (3.94)	-.0352 (0.34)	-.0263 (0.19)	-.0266 (0.18)	-.0493 (0.62)	.0701 (2.38)	.0405 (0.76)
FIRST	.0050 (0.60)	.0059 (0.69)	-.0076 (1.03)	-.0026 (0.10)	.1742 (28.04)	.1410 (15.34)	.2024 (36.01)	.1440 (15.21)	.0185 (0.56)	.0162 (0.35)
TWIN	-.0143 (0.54)	-.0207 (1.07)	.0229 (1.06)	.0108 (0.22)	-.0365 (0.13)	.1313 (1.70)	-.0341 (0.11)	.1193 (1.33)	-.0308 (0.17)	-.0428 (0.31)
MALE	-.0026 (0.20)	-.0028 (0.23)	-.0065 (0.93)	-.0059 (0.77)	- -	- -	- -	- -	- -	- -

*Coefficients are statistically significant at the 5 percent level if the "F" is greater than 3.84 for a two-tailed test, or 2.69 for a one-tailed test. The explanatory variables in Equation 1 are FINC, HFINC, FEDUCAT, MEDUCAT, FLANG, NOFATH, MALE (when relevant), FIRST, TWIN, NEAST, MWEST, SOUTH, URB1, URB2, URB3, and NURB. The explanatory variables in Equation 2 include those in Equation 1 and also LESS20, LIGHT1, LIGHT2, CABN, MWORKPT, MWORKFT, LMAG, HMAG, DENT12 and DENTIST3.

subsequent tables because none of its explanatory variable coefficients are statistically significant).

The partial effects of income on the various health measures are surprisingly small and are statistically significant only for the variables PFGHEALTH, SCHABS, IWEIGHT, and APERI. As an example of the magnitudes of these coefficients, a $1,000 increase in annual family income is associated with a decrease of only .01 in the probability of parents' rating their children's health as poorer than "very good" (see eq. 1). The magnitudes tend to become even smaller when the set of endogenous variables is included (eq. 2), but the pattern of statistical significance is not altered. In addition, in some cases higher income is associated with poorer rather than better health (HDBP, ALLEG, ACABN, TENS, SCHABS), although this perverse relationship is statistically significant only for SCHABS. With respect to differences in income effects between low and high income families, a significant difference is observed only for SCHABS. In that case the negative income effect in the low income class completely disappears for the high income class (the coefficients of FINC and HFINC are opposite in sign and approximately equal in magnitude). To summarize these varied results, while income does have a significant relationship with four of the eleven health measures, on balance, the evidence leads one to conclude that, overall, income is not an important factor for explaining health variations among the children in this sample.[36]

Unlike family income, the parents' educational attainment has significant effects on most of the health measures. In fact, one or both of the parents' education measures is statistically significant except when ACABN and SCHABS are the dependent variables. This is true whether or not the set of endogenous variables is included in all equations except the weight equation. Both for the height and weight measures the inclusion of the endogenous variables causes a substantial (about 50 percent on average) decline in the magnitude of the education coefficients. Contrary to expectations, significant inverse relationships between health and parents' education are reported for ALLEG and TENS. This may be a result of a reporting bias in that more educated parents may be more sensitive to subtle aspects of ill health in their children. Alternatively, more educated parents may be more demanding regarding their children's behavior and achievement, creating greater tension and accompanying allergies. With the exception of these two measures of the "new morbidity," however, the coefficients of the parents' educational attainment variables are consistent with the notion that higher parental education leads to greater efficiency in home health production.[37]

Children from families where a foreign language is spoken in the home do not have significantly different health levels from other children except with respect to the measures ACABN and TENS. Children from such families are more likely to exhibit an acquired abnormality, but they are less likely to be considered tense by their parents.

Differences in children's health associated with the presence or absence of a father in the household at the time of the survey are not uniform across the various health measures, and in many cases, are not statistically significant. The coefficient of the dummy variable NOFATH indicates significant positive associations with better health when HDPB and ACABN are the health measures, and significant negative associations with better health when health is measured by school absenteeism. In the cases where NOFATH is not significant, both positive and negative health relationships are again reported.[38] The somewhat unexpected conclusion to be drawn here, then, is that having an absent father is neither a clear health advantage nor a clear health disadvantage to a child. One possible explanation is that, with family income held constant, unmarried mothers have more resources to allocate to their own consumption and to their children than do married couples.

Among the exogenous family characteristics considered in this subsection, it is not family income that appears to be of outstanding importance in explaining variations in children's health levels (though income does play a role), but rather parents' educational attainment. With the exception of the two measures relating to the "new morbidity" (ALLEG and TENS) children's health status significantly improves as their parents' educational attainment increases. The remaining two exogenous characteristics of families--speaking a foreign language in the home and having an absent father--appear to have minimal negative impacts on children's health, and in some cases, may even be positively associated with health.

C. Region and City Size

It is clear from the coefficients of the region and city size variables (in Table VI) that another characteristic of families--their location--accounts for larger differences in children's health than do those characteristics discussed above. Significant regional differences exist for the variables PFGHEALTH, ABVIS, ALLEG, ACABN, APERI, IHEIGHT, and IWEIGHT); and significant city size differences exist for PFGHEALTH, ABVIS, HDBP, ALLEG, TENS, IWEIGHT, and APERI. Regional and city size differences in children's health are not, however, uniform; there is no "best" place to live. For example, health is best in the West when measured by APERI and ACABN, but worst when measured by ALLEG, IHEIGHT, and IWEIGHT. Similarly, health is best in non-urbanized non-rural areas when measured by HDBP, but is best in medium sized cities (1 to 3 million people) when measured by PFGHEALTH and ALLEG.

TABLE VI
Coefficients of Region and City Size Variables*
("F" statistics in parentheses)

Explanatory Variable	PFGHEALTH Eq. (1)	PFGHEALTH Eq. (2)	ABVIS Eq. (1)	ABVIS Eq. (2)	HDBP Eq. (1)	HDBP Eq. (2)	ALLEG Eq. (1)	ALLEG Eq. (2)	TENS Eq. (1)	TENS Eq. (2)
NEAST	-.0733 (10.74)	-.0663 (8.72)	.0314 (4.42)	.0281 (3.48)	.0107 (1.03)	.0086 (0.65)	-.0693 (17.26)	-.0759 (20.41)	.0029 (0.02)	.0005 (0.00)
MWEST	-.0325 (2.69)	-.0302 (2.30)	.0145 (1.20)	.0114 (0.73)	.0042 (0.20)	.0032 (0.12)	-.0607 (16.92)	-.0625 (17.65)	-.0020 (0.01)	-.0052 (0.06)
SOUTH	.0718 (9.19)	.0702 (8.80)	-.0057 (0.13)	-.0089 (0.32)	.0156 (1.95)	.0141 (1.59)	-.0477 (7.31)	-.0536 (9.18)	.0176 (0.52)	.0163 (0.44)
URB1	.0093 (0.17)	.0161 (0.50)	.0161 (1.12)	.0148 (0.94)	.0110 (1.05)	.0097 (0.81)	-.0007 (0.002)	-.0071 (0.18)	.0544 (5.33)	.0549 (5.39)
URB2	-.0732 (8.13)	-.0695 (7.39)	.0145 (0.72)	.0142 (0.68)	-.0015 (0.02)	-.0021 (0.03)	-.0491 (6.57)	-.0527 (7.60)	.0854 (10.38)	.0869 (10.72)
URB3	.0003 (0.00)	.0076 (0.12)	.0272 (3.48)	.0258 (3.09)	.0127 (1.52)	.0111 (1.16)	.0240 (2.18)	.0172 (1.11)	.0555 (6.05)	.0572 (6.35)
NURB	-.0398 (2.92)	-.0423 (3.31)	.0075 (0.23)	.0073 (0.22)	-.0328 (8.96)	-.0317 (8.32)	.0068 (0.16)	.0050 (0.08)	.0371 (2.39)	.0407 (2.85)

(continued on next page)

TABLE VI (concluded)

Explanatory Variable	ACABN Eq. (1)	ACABN Eq. (2)	SCHABS Eq. (1)	SCHABS Eq. (2)	IHEIGHT Eq. (1)	IHEIGHT Eq. (2)	IWEIGHT Eq. (1)	IWEIGHT Eq. (2)	APERI Eq. (1)	APERI Eq. (2)
NEAST	.0217 (6.15)	.0236 (7.18)	.0124 (1.50)	.0142 (1.94)	.0669 (2.26)	.0327 (0.55)	.0454 (0.99)	.0221 (0.24)	.4704 (198.16)	.4894 (211.47)
MWEST	.0242 (9.77)	.0251 (10.30)	.0060 (0.45)	.0076 (0.71)	.1121 (8.06)	.0969 (6.08)	.1423 (12.36)	.1406 (12.19)	.1114 (14.16)	.1225 (16.86)
SOUTH	.0165 (3.17)	.0161 (3.00)	-.0057 (0.28)	-.0050 (0.21)	.0100 (0.05)	-.0058 (0.02)	.0272 (0.32)	.0065 (0.02)	.3566 (101.50)	.3642 (105.51)
URB1	-.0146 (2.70)	-.0135 (2.28)	-.0086 (0.69)	-.0079 (0.58)	.0262 (0.33)	.0058 (0.02)	.1155 (6.13)	.0951 (4.26)	-.0255 (0.56)	-.0175 (0.26)
URB2	-.0042 (0.17)	-.0037 (0.14)	-.0017 (0.02)	-.0011 (0.01)	.0543 (1.12)	.0470 (0.87)	.1065 (4.12)	.0986 (3.63)	.0066 (0.03)	.0110 (0.08)
URB3	-.0066 (0.59)	-.0053 (0.38)	-.0080 (0.66)	-.0072 (0.53)	.0024 (0.003)	-.0153 (0.13)	-.0828 (3.44)	-.0987 (4.98)	.0344 (1.11)	.0412 (1.58)
NURB	.0002 (0.001)	-.0005 (0.003)	.0082 (0.61)	.0086 (0.68)	-.0499 (1.16)	-.0388 (0.72)	-.0073 (0.02)	-.0068 (0.02)	-.0387 (1.24)	-.0436 (1.57)

*See Table V.

The reasons for these differences are varied and cannot be explored with the types of data used in this paper. We suggest a number of possibilities: climate, air pollution levels, fluoridation levels, ethnic composition of the population, as well as unmeasured differences in the availability and price of medical care. In addition, there are differences in stress and tension associated with living in cities of various sizes or in rural areas. To distinguish between these explanations, one would need to match up the data in the Cycle II survey with local measures of variables like those suggested above. The point we wish to emphasize here, however, is that even when a large number of individual family demographic and economic characteristics are held constant, large unexplained regional and city size differences in children's health levels exist. These unexplained differences are clearly an important issue for future epidemiological research.

D. Exogenous Child Endowments

Coefficient estimates for the three exogenous child endowment characteristics--FIRST, TWIN, and MALE--appear at the bottom of Table V. First born children have significantly better health when measured by PFGHEALTH, IHEIGHT, and IWEIGHT, and significantly poorer health when measured by ALLEG and TENS. Additional insight regarding the role of this endowment measure is obtained by looking at how its coefficient alters when the set of endogenous variables is included. In this case both the benefits and disadvantages of being a first born child diminish substantially (except for TENS), though FIRST remains statistically significant. Thus, the impact on child health of being a first born operates in part via such endogenous variables as family size, mother's work status, and dentist visits.

These reported health differences between first borns and others are consistent with the notion that first born children receive relatively more time and attention from their parents than other children: their rate of physical development is more rapid (despite the fact that they tend to have a lower weight at birth), but at the same time they exhibit a greater incidence of allergies and tension problems. The latter is a likely result of the increased parental attention (and accompanying expectations) directed at first borns.

With respect to the other two child characteristics, male children are less likely to have poor vision and more likely to have allergies and be tense than are female children. These sex differences remain unaffected by the inclusion of the endogenous variables. Twins differ significantly from other children in their health status only in that they are less likely to have allergies. To conclude, there are health differences associated with these exogenous child characteristics, in particular with being a first born child, although these differences are not uniform across the various measures of health.

E. Endogenous Child Health Endowments

The coefficients of the five endogenous measures of the child's health endowment appear in Table VII. Three of these measures reflect differences in the birth outcome (LIGHT1, LIGHT2, CABN), and the remaining two indicate the mother's age at the time of the child's birth (LMAG, HMAG). One or more of the three birth outcome variables is significantly associated with poorer current health for the measures PFGHEALTH, ABVIS, ACABN, SCHABS, IHEIGHT, IWEIGHT, and APERI. Especially notable are the effects of these variables on height and weight: babies of low birth weight have subsequent height

TABLE VII

Coefficients of Family Size and of Endogenous Endowments*

("F" statistics in parentheses)

Explanatory Variable	PFGHEALTH	ABVIS	HDBP	ALLEG	TENS	ACABN	SCHABS	IHEIGHT	IWEIGHT	APERI
LIGHT1	.0043 (0.004)	.0367 (0.66)	.0448 (1.99)	.0006 (0.000)	.1065 (2.33)	.0584 (4.91)	.0600 (3.81)	-.5135 (15.02)	-.3918 (8.32)	.0928 (0.85)
LIGHT2	.1113 (9.08)	-.0102 (0.17)	-.0001 (0.00)	.0003 (0.000)	.0489 (1.63)	-.0005 (0.001)	.0156 (0.86)	-.4529 (38.63)	-.3830 (26.27)	-.0203 (0.13)
CABN	.0534 (2.48)	.0590 (6.73)	.0057 (0.13)	.0068 (0.07)	.0504 (2.05)	.0381 (8.21)	-.0172 (1.20)	-.1506 (5.08)	-.1551 (5.13)	.0896 (3.12)
LMAG	-.0557 (3.42)	-.0034 (0.03)	-.0113 (0.63)	-.0024 (0.01)	-.0156 (0.25)	-.0089 (0.57)	-.0125 (0.79)	-.1783 (9.01)	-.1860 (9.32)	.1229 (7.41)
HMAG	.0992 (4.72)	.0132 (0.65)	.0222 (3.68)	-.0100 (0.30)	.0305 (1.44)	-.0004 (0.002)	.0090 (0.66)	.1315 (7.43)	.1716 (12.04)	.0169 (0.21)
LESS20	.0067 (1.85)	-.0049 (2.20)	-.0024 (1.11)	-.0139 (14.32)	-.0009 (0.03)	-.0009 (0.22)	.0020 (0.80)	-.0536 (30.70)	-.0079 (61.51)	.0110 (2.24)

*Coefficients are statistically significant at the 5 percent level if the "F" is greater than 3.84 for a two-tailed test, or 2.69 for a one-tailed test. The explanatory variables included in the equations are as for Equation 2 (see note to Table V).

and weight of almost half a standard deviation below the mean for their age-sex cohort.

The results for the mother's age variables are less uniform. Children of young mothers are significantly healthier when health is measured by PFGHEALTH and significantly less healthy for height, weight, and the peridontal index. Conversely, children of older mothers are significantly less healthy according to the results for PFGHEALTH and HDBP and more healthy for height and weight. These observed relationships between mother's age and children's health reflect two forces that go in opposite directions. Relatively young mothers are probably in better physical health when they give birth, but they are more likely to have unwanted births and consequently receive poorer prenatal care and spend less time with their children. Births at relatively old ages pose health risks both to mothers and children, but older mothers might be more efficient in caring for their children.

As mentioned earlier, all five of these variables are endogenous in that they are determined simultaneously with the health measures. Therefore the reported significant relationship between a poor birth outcome and poorer current health can be interpreted not only as the result of behavioral or physiological relationships, but also as the impact of unmeasured factors that affect both early and current health (tastes, attitudes towards medical care, etc.). A similar remark can be made regarding the reported coefficients of the two mother's age variables.

F. Family Size

Family size has significant health effects only for height, weight, and the incidence of allergies (see Table VI). Children from larger families tend to be shorter and thinner than other children, but they also exhibit a smaller probability of having allergies. Whether these relationships reflect quality-quantity substitution on the part of the parents or some alternative mechanism (such as the effects of an exogenous constraint on the amount of parents' time available to each child) cannot be determined.

G. Mother's Work Status

The two mother's work status variables (MWORKFT, MWORKPT) are not significantly related to most of the health measures (see Table VIII).[39] When an "F" test on the pair of variable coefficients is conducted, they have significant effects only for IHEIGHT and APERI (we do not show these tests). In both cases, children of working mothers have poorer health than do other children. The coefficients of the individual work status variables indicate that working full-time has a greater impact on the periodontal index, while working part-time has a greater impact on height. In general these results reveal that participation by mothers in the labor market is detrimental to the health of their children only with respect to two of the measures which reflect the child's nutritional status. This finding is especially plausible in that working mothers are clearly less able to supervise their children's diets.

H. Medical Care

The regression coefficients of the dichotomous variables that identify children who last saw a dentist more than one year ago (DENT12) and children who have never seen a dentist (DENTIST3) appear in Table VIII. These two variables serve as negative proxies of the amount of preventive medical care and positive proxies of the price of preventive care: parents of children who have seen a dentist within the past year are more likely to obtain preventive medical care services for their children and to face a lower price

TABLE VIII
Coefficients of Mother's Work Status and Medical Care Variables*
("F" statistics in parentheses)

Explanatory Variable	PFGHEALTH	ABVIS	HDBP	ALLEG	TENS	ACABN	SCHABS	IHEIGHT	IWEIGHT	APERI
MWORKPT	.0333 (2.24)	-.0139 (0.87)	-.0006 (0.003)	-.0023 (0.02)	-.0114 (0.25)	-.0057 (0.42)	.0001 (0.000)	-.1272 (8.41)	-.0179 (0.16)	.0075 (0.05)
MWORKFT	.0345 (2.62)	.0066 (0.21)	.0036 (0.13)	.0102 (0.41)	-.0322 (2.12)	.0123 (2.16)	.0025 (0.07)	-.0624 (2.20)	.0164 (0.15)	.0849 (7.05)
DENT12	.0992 (22.41)	-.0009 (0.004)	-.0211 (4.55)	-.0423 (7.30)	-.0263 (1.46)	.0161 (3.83)	.0026 (0.07)	-.1051 (6.47)	-.0164 (0.15)	.0726 (5.34)
DENTIST3	.0887 (15.76)	-.0227 (2.29)	-.0110 (1.08)	-.0453 (7.34)	.0012 (0.003)	.0153 (3.06)	.0156 (2.30)	-.2098 (22.65)	-.1067 (5.57)	.0897 (7.18)

*See Table VII.

of care. These parents may also have preferences for high quality children. When the periodontal index is the health measure, these two variables also proxy direct inputs in the production of dental health.

One or both of these medical care proxies are significantly related to seven of the ten health measures (all but ABVIS, TENS, and SCHABS). For five of the seven (PFGHEALTH, ACABN, IHEIGHT, IWEIGHT, and APERI) children who saw a dentist within the past year have higher levels of health than children who saw a dentist more than one year ago or children who never saw a dentist. This relationship is reversed for ALLEG and HDBP. The perverse allergy effects probably indicate a greater awareness of allergy problems among parents who took their children to a dentist within the past year. The blood pressure effect is puzzling, and we offer no explanation of it.

These preventive medical care proxies appear to have the largest impacts on health measures that reflect basic nutritional status. In the height, weight, and peridontal index equation, the coefficient of the variable that identifies children who never saw a dentist is large relative to the coefficients of other independent variables. In the height regression the coefficient of DENTIST3 equals 21 percent of the standard deviation in height. The corresponding figures in the weight and peridontal index regressions are 11 percent and 12 percent, respectively. Not only are these coefficients large, but they apply to a substantial proportion of our sample: 18 percent of the children in the sample never saw a dentist.

The statistically significant effects of the two dental variables on the periodontal index are particularly noteworthy since in this case our estimates directly measure the effect of oral health input on oral health output. In fact, for this health measure the beneficial input effects that we report are likely to understate true input effects because of reverse causality that runs from a reduction in oral health to an increase in the probability of contacting a dentist.

V. Income Differences in Children's Health

Much of the attention policy makers and health professionals direct at children's health focuses on differences related to family income levels. In this section, we discuss how our results can be used to provide additional insight into the nature and causes of these differences.

Our findings of small, and, in most cases, nonsignificant income effects on children's health may appear to be at variance with accepted opinion. Indeed, in our introduction we refer to large reported differences in health associated with differences in family income. One explanation of these contradicting conclusions is that the "conventional wisdom" is based to a large extent on income differentials in infant mortality and low birth weight. Our paper does not deal with infant mortality, and low birth weight is treated as an explanatory variable rather than one to be explained. Moreover, our sample consists of a cohort of children who survived beyond the first year of life so that a substantial proportion of low birth weight infants are not included. [It is well known that low birth weight has a strong positive relationship with subsequent infant mortality [see Lewit (40)].

In addressing the health of children in mid-childhood, we find that while for some health measures simple income comparisons do reveal large differences between the health of children from low and high income families, these differences largely disappear when one controls for differences in other family characteristics that are highly correlated with income. To demonstrate how large a portion of the apparent (or gross) income differences would be attributed to associated family characteristics, in Table IX we provide illustrative calculations for the measures PFGHEALTH, IHEIGHT, IWEIGHT, ALLEG, and APERI. These are the only health measures for which statistically significant gross income differences are observed in our sample. The third column of Table IX shows the gross differences in these measures between children in families with annual income under $5,000 and those in families with annual income of $5,000 or more. A $5,000 family income cutoff is selected because it identifies the lowest quartile of the income distribution. The gross differences in column (3) are to be compared to health differences that are allocated to income when all other exogenous explanatory variables in our basic equations are held constant [column (4)]. The "net" income effects are less than one-half (and in some cases, one-quarter) of the observed gross income differences for these five health measures. The difference between net and gross income effects becomes even larger when the set of endogenous variables is also held constant [column (5)]. The conclusion to be drawn is clear: gross income differences in health greatly overstate the true relationship between family income and health.

If the reported gross income differences are not primarily a result of differences in income, what does account for them? To answer this question we calculate how much of the gross high-low income differences in the above five health variables can be attributed to specific explanatory variables or sets of these variables. The procedure is simply to multiply the coefficients of these explanatory variables by the differences in their mean values in the high and low family income samples of children. The resulting

TABLE IX
Income Differences in Selected Current Health Measures

Variable	Mean, Family Income ≥ $5,000	Mean, Family Income < $5,000	Gross Difference[a]	Net Difference[b] Equation (1)	Equation (2)
PFGHEALTH	.394	.589	-.195	-.079	-.072
IHEIGHT	.099	-.181	.280	.079	.053
IWEIGHT	.106	-.114	.220	.091	.066
APERI	-.097	.117	-.214	-.077	-.071
ALLEG	.176	.108	.068	.016	.008

[a]Gross difference equals column (1) minus column (2). As shown in Table X, the gross differences vary little from differences that are predicted on the basis of a regression of the health variables on all the independent variables.

[b]Net difference is the difference in mean health levels between the two income classes predicted on the basis of the income coefficients in Table V. LESS20, LIGHT1, LIGHT2, CABN, MWORKPT, MWORKFT, LMAG, HMAG, DENT12 and DENTIST3 are excluded for equation (1) and included for equation (2).

estimates (in Table X) illustrate how much of the gross difference would disappear if the low income class is given the same mean values of the independent variables as the high income class and if the relationship between health and the explanatory variables is the same in both income classes. They also identify which explanatory variables are responsible for the sizable gap between the gross and the net income effects in Table IX.

Several results in Table X are noteworthy. First, almost all of the observed differences in the five health measures between the high and low income subsamples can be accounted for by differences in the independent variables that we have included in our empirical work [either equation (1) or (2)]. Second, a detailed examination of the decomposition that uses only the exogenous variables [equation (1)] indicates that differences in parents' schooling account for a large portion of observed gross income differences in health. Indeed, for three of the five variables--APERI, IHEIGHT, and IWEIGHT--differences in parents' average schooling between high and low income families account for a larger portion of the health differences than do differences in income. Parents' schooling remains as an important explanatory factor even when the set of endogenous variables is entered in the equation. In the latter case, however, dental care and, to a lesser extent, family size also make substantial contributions to the gross income differences in health.

TABLE X
Components of the Difference in PFGHEALTH, APERI, IHEIGHT, IWEIGHT and ALLEG
Between Children from High and Low Income Families*

Component	PFGHEALTH		APERI		IHEIGHT		IWEIGHT		ALLEG	
	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)	Eq. (1)	Eq. (2)
Family income	-.079	-.072	-.077	-.071	.079	.053	.091	.066	.016	.008
Parents schooling	-.071	-.057	-.131	-.111	.115	.070	.062	.027	.045	.035
Other exogenous family characteristics	.001	.004	-.011	-.005	.012	.010	.002	.006	.004	.004
Exogenous child endowments	-.003	-.002	.001	.001	.008	.007	.010	.007	.003	.002
Region	-.025	-.024	.019	.021	.013	.010	.008	.008	-.005	-.005
City size	-.005	-.008	-.001	.001	.008	.005	.021	.017	-.004	-.005
Family size	-	-.004	-	-.006	-	.031	-	.044	-	.008
Endogenous endowments	-	.000	-	-.008	-	.014	-	.013	-	.000
Mother's work status	-	.001	-	.001	-	-.005	-	-.001	-	-.000
Dental care	-	-.031	-	-.028	-	.059	-	.026	-	.015
Total = Predicted Gross Difference	-.182	-.193	-.200	-.205	.235	.254	.194	.213	.059	.062
Actual Gross Difference		-.195		-.214		.280		.220		.068

*Only exogenous variables are in Equation 1. All variables are in Equation 2.

VI. Summary and Implications

In this study multivariate techniques have been employed to examine the determinants of eleven components of health in a national sample of white children between the ages of six and eleven. The most important empirical results and their policy implications are highlighted below.

The partial effects of family income on health are small and seldom statistically significant. Indeed, some health problems--high blood pressure, allergies, and tension--are more likely to occur among children from high income families. This phenomenon can be viewed as the early forerunner of the positive relationship between income and morbidity and mortality rates observed for adults in the United States [for example, Auster, et al. (41) and Grossman (25) and (42)]. The general finding of small partial income effects is supported by analysis of gross health differences between children from lower (under $5,000 per annum) and higher ($5,000 per annum and over) income families. In those cases where significant gross health differences do exist between children from these two income classes, decomposition of these gross differences shows them to be attributable in large part to exogenous factors other than income itself.

In contrast to family income, parents' schooling is an important determinant of children's health. In most instances children of well educated parents are in better health than those of less well educated parents. In fact, for four of the five health measures that have a significant gross correlation with income, much of this observed income difference is accounted for by associated differences in parents' schooling. This would suggest that policies to raise parents' schooling would not only benefit their children's health, but would also reduce differences in health between children from low and high income families.

The other exogenous family characteristics studied--the absence of a father in the home and the use of a foreign language in the home--have at best small impacts on children's health. A similar conclusion is to be drawn regarding the child's exogenous endowments--his sex, twin status, and whether he is a first-born--with the exception of the latter. First born children do have some health advantages, but they also rate more poorly than other children when health factors related to the new morbidity (allergies and tension) are examined.

The final type of exogenous variables studied describe the region and urban-rural characteristics of the child's residence. Our major finding with respect to these variables is that locational factors play an important, but largely unexplained, role in determining children's health levels. This finding emphasizes the need for additional research investigating the source of these striking locational effects on children's health.

Among the various endogenous variables studied, our most interesting results are for the variables representing mother's labor force status, family size, and the frequency with which the child received dental care. The mother's labor force status and family size variables are interesting primarily because of their lack of importance. That is, both of these factors have small health effects and are strongly related only to the health variables representing the child's nutritional status (height, weight, and the periodontal index). Children whose mothers are in the labor force or who come from larger families are likely to score more poorly with respect to these nutritional measures. In contrast with the roles of mother's labor force status and family size, the dental care variables have large and significant impacts for most of the health measures. Interpretation of this finding is not altogether clear-cut, however, since the dental care variables proxy not only the price and availability of medical care, but also family attitudes towards preventive health care and towards health in general.

The implications of our findings are at the same time both heartening and disheartening. For example, the finding that differences in health related solely to income are smaller than commonly believed implies that policies that aim to improve the well-being of children via income transfers, such as those advocated by the recent Carnegie Council on Children [Keniston (3)] would have, at best, very small effects on health. A related implication pertains to proposals by Newberger, et al. (43), Keniston (3), and Marmor (44) to restrict national health insurance to rather complete prenatal and pediatric care coverage to offset variations in health associated with income. Again, our results indicate that there is not much to offset, even though pediatric care utilization is very sensitive to family income [Colle and Grossman (45)]. At the same time, however, our findings regarding the important role of the dental care variables suggest that policies directed at either improving the availability of medical care or altering public attitudes towards preventive care could have large health payoffs for children in all types of families.

Other favorable implications of our findings relate to three recent striking trends in the demography of U.S. families. These trends are the increase in the proportion of families headed by women, the increase in the labor force participation rate of married women with children, and the reduction in family size. We find that the absence of a father in the household has little impact on children's health. Therefore, while the recent rise in the divorce rate might affect certain dimensions of children's well-being, health does not appear to be one of them. The same comment applies to the increase in labor force participation rates of married women with the exception that with respect to our two best measures of long-run nutritional status--height and the periodontal index--children rate more poorly if the mother works. Since, however, height is negatively related to family size, the detrimental impacts of increases in labor force participation rates are offset to some extent by the beneficial impacts of reductions in family size.

The implications of our results regarding parents' schooling may appear to be clear-cut at face value since parents' schooling plays such an important role in determining children's health. Caution and more research are required, however, before actually applying them to schooling policies. First, the differences in years of parents' schooling between the high and low income samples are very large (three years both for mothers and fathers), and these would probably be extremely costly to eliminate. But more important, the mechanisms by which parents' schooling affects children's health still are not well known. Consider, for example, the finding that parents' schooling is an important determinant of children's height. This result has a very definite policy implication if the mechanism at work is a positive correlation between schooling and nutritional intakes or between schooling and the knowledge of what constitutes an appropriate diet. The policy implication is much less clear-cut if the mechanism at work is a positive relationship between parents' schooling and genetic inheritance that is not fully captured by the exogenous endowment and early health variables in the regressions. Clearly, more research on the exact role of parents' schooling is needed.

The diverse findings in this paper underscore the multidimensional nature of children's health. In fact, our results illustrate how the use of a single index could be misleading since the various family characteristics can have positive impacts on some components of good health and negative impacts on others. For example, an important distinction is found between the relationship of parents income and education with the more traditional health measures (height, the periodontal index) as compared to measures of the "new morbidity" (the presence of allergies and tension). These two family characteristics have positive impacts on the traditional measures but negative impacts on measures of the new morbidity. One can speculate that the likely upward trend in the new morbidity will lead to more utilization of physicians' services for problems that are in many cases not amenable to treatment by physicians, suggesting that some modification in the training received by pediatricians and in the delivery of pediatric care services would be desirable.

Finally, although we do not altogether resist speculating about the implications of our empirical findings, we fully understand that this paper falls squarely within the sphere of traditional epidemiological research. We document the statistical relationships between family characteristics and measures of children's health in detail, but even though we outline the possible role of economic factors, we cannot determine the exact nature of the mechanisms that generate these relationships. Nor was it possible to establish the causal nature of these relationships in a definitive sense. One important and unambiguous conclusion of our study, however, is that the present tendency to base government child health programs on simplistic notions that income is the primary source of differences in children's health will not lead towards fruitful or successful public policy regarding children's health.

FOOTNOTES

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[1] This change in emphasis is partially the result of the Coleman Report and subsequent research, which showed that the effects of school quality on children's achievement may be small relative to the effects of family characteristics. Averch, et al. (2) provide an excellent review of this literature.

[2] Most states require children to receive certain immunizations before they may begin attending school. An exception to the text statement is Connecticut, which requires school children to have physical examinations every three years [Foltz and Brown (4)].

[3] This definition of the new morbidity is quoted from Haggerty, et al. (5), p. 316.

[4] This point is made by Starfield (6) who emphasizes that although many persons have studied the effects of medical care and socioeconomic characteristics on infant mortality, relatively few have examined the effects of these variables on the health of children who survive the first year of life. For

a few recent exceptions, see Kaplan, et al.(7); Hu (8); Kessner (9); Haggerty, et al. (5); and Inman (10).

[5]This evidence comes from Cycles II and III of the Health Examination Survey and is reported in NCHS (11), pp. 22-26.

[6]A full description of the sample, the sampling technique, and the data collection is presented in NCHS (12). The one deficiency of this sample from the point of view of studying children's health is the exclusion of children in institutions. To the extent that these children are more likely to have serious and disabling physical conditions, the reported incidence of certain conditions will be lower in our sample than in the entire population of children. In addition, if the probability of the institutionalization of a child with a given condition depends on the various family characteristics studied here, our results will incorporate unknown biases. The number of institutionalized children is small, however, at about four tenths of a percent of all children aged 5 through 13 years. [This is the proportion of 5-13 year-olds living in "group quarters" in 1970 according to the U.S. Bureau of the Census (13), Tables 52 and 205. The corresponding percentages by race are .38 percent for whites and .7 percent for blacks.]

[7]Introducing uncertainty about the number and quality of children complicates the model, but many of the basic insights provided by the notion of both a quantity and quality dimension of children remain valid. Ben Porath and Welch (16) illustrate how uncertainty regarding one aspect of quality--the child's sex--affects fertility.

[8]Recent medical advances allow some types of poor genetic endowments to be detected inter utero and defective fetuses aborted, so that parents can now partially control their children's genetic endowments.

[9] See Willis (15) and Becker and Lewis (14) for a full development of these points.

[10] Associated with this output demand function are input demand functions for parents' time, medical care, and other market health inputs. These input demand functions will not be studied here.

[11] Presumably, parents' education raises efficiency in the production of many household commodities. Therefore, there is an "own price effect" due to an improvement in the efficiency of producing children's health and a "cross price effect" due to an improvement in the efficiency of producing other commodities. The statement in the text with respect to the impact of parents' education on children's health assumes that the "own price effect" outweighs the "cross price effect" if the two effects go in opposite directions.

[12] The model outlined above is not directed at explaining variations in a child's health during his childhood, but rather treats child health as a single datum--his permanent health measured, say, at the end of his childhood or as an average over his childhood. If one wanted to investigate changes in health during childhood, one would want to develop a model which explicitly examines how patterns of health and health investments over childhood are determined by life cycle variations in both the prices of health inputs and the marginal products of health investments.

[13] Edwards and Grossman (17) and (18) use this model to study children's health and intellectual development, Leibowitz and Friedman (19) use it to study health inputs, Tomes (20) uses it to examine years of schooling attained, and Ishikawa (21) uses it to explain intergenerational transfers of education

and financial wealth. Both Ishikawa (21) and Leibowitz and Friedman (19) treat family size as exogenous.

[14] See, for example Sullivan (22), Berg (23), and, more recently, Ware (24).

[15] See Grossman (25), p. 58. This definition is also very similar to that proposed in Torrance (26).

[16] A good discussion of the subsidiary issue of how one measures disability in children can be found in Schack and Starfield (27).

[17] Of course, there is a positive relationship between the two in the sense that a child with low health capital is more likely to contract some acute conditions and to have them for a more extended time period. For example, Birch and Gussow (28) discuss how nutrition (which is clearly a determinant of "permanent" health status) and disease are intimately related.

[18] The earlier theoretical discussion pertains to children's permanent health status measured at the end of their childhood, while health measures in the Cycle II data are for 6 to 11 year-old children. Our analysis implicitly assumes that health in mid-childhood is a good proxy for the health stocks at the end of childhood.

[19] In earlier work some attempts were made to condense the health information using principal component analysis. The analysis yielded almost as many equally weighted components as there were initial health measures.

[20]The studies we consulted are: Wallace (29); Mechanic (30); Mindlin and Lobach (31); Talbot, et al. (32); Kaplan, et al. (7); Hu (8); Schack and Starfield (27); Kessner (9); Haggerty, et al. (5); and Inman (10).

[21]The following physicians gave us extremely helpful advice. John McNamara, M.D., then Assistant Professor of Public Health and Pediatrics at Columbia University School of Public Health and Associate Commissioner in the New York City Department of Health; Roy Brown, M.D., Associate Professor of Community Medicine and Pediatrics at the Mount Sinai School of Medicine of the City University of New York; Thomas Travers, D.D.S., Director of Ambulatory Care in the New York City Department of Health; and Ruth T. Gross, Professor of Pediatrics and Director of Ambulatory Pediatrics, Stanford University Medical Center, Stanford, California.

[22]If the actual height or weight of each age-sex group is normally distributed, IHEIGHT and IWEIGHT could be translated directly into the child's height or weight percentile. In addition to the continuous height and weight measures, we also experimented with discrete measures identifying children who are more than two standard deviations from the mean height or weight for their age-sex cohort. These measures were used to allow for non-continuous relationships between height (or weight) and family characteristics. For example, beyond some weight level, problems with obesity start to develop, so that more weight is no longer better than less weight. Results using these discrete measures did not differ greatly from those based on using IHEIGHT and IWEIGHT, so we do not report them here.

[23]One might argue that corrected rather than uncorrected vision is the appropriate measure to use here. Unfortunately, information about corrected

vision is not available in the Cycle II data. Information about whether or not the child wears glasses is available, but it is not clear that the glasses he wears actually correct his vision defect. Kessner (9), for example, finds that 40 percent of children in a low income sample who were tested with their glasses failed a visual acuity test.

[24] In defining ACABN, we exclude abnormalities resulting from accidents or injuries because these are likely to reflect transitory rather than permanent health variations.

[25] The periodontal index suffers from the defect that it is subject to intra-rater and inter-rater variability. We have experimented with a somewhat more objective measure of oral health, the number of decayed permanent and primary teeth adjusted for age and sex, and have obtained results similar to those for the peridontal index. Compared to the number of decayed teeth, the periodontal index reflects more serious oral health problems.

[26] There is no school form for approximately 500 children in the Cycle II data set. Since excessive absence due to illness is the only variable taken from the school form, children without the school form are eliminated from the empirical analysis only when school absence is the dependent variable.

[27] A $7,000 cutoff point is used because it is most consistent with available evidence on the distribution of inheritances across families. See Edwards and Grossman (17) for an elaboration of this point. Note that the family income measure is an imperfect measure of long-run income and has an endogenous component because it does not hold constant the father's experience and the mother's labor force status. Therefore, we experimented with an income measure that held these two factors constant. The adjusted income

variable was very highly correlated with FINC (the correlation coefficient was greater than .99) and the regression results were not altered when adjusted income was used in place of FINC. Consequently, we report results based on the use of FINC in this paper.

[28]See, for example, Birch and Gussow (28). Cycle II does not distinguish children who are born prematurely, so we cannot determine to what extent low birth weight is a result of prematurity or of other factors.

[29]In the future the National Center for Health Statistics might provide us with area-specific input availability and price measures. This will enable us to examine the effects of medical care prices on health outputs.

[30]Information about the time of the child's last visit to a doctor is also available in the data, but would be greatly contaminated by the child's health level. We refer to the well-known reverse causality between health and medical care.

[31]In actuality even some of the exogenous variables may not be truly exogenous. For example, women who plan to have large families will be less likely to make large investments in their own education. Or, families for whom children's health is an important component of child quality may choose to live in healthier (non-urban) areas of the country. Similarly, men who have a high preference for children may choose less intensive jobs--which presumably yield lower wages--so that they can spend more time with their children.

[32]In the case of the family size variable, for example, it is very difficult to identify exogenous variables that enter the family size

structural equation or the children's health structural equation but not both.

[33]Missing information for birth weight (818 observations), FLANG (324 observations), and income (290 observations) account for most of the missing observations. In addition, children who turned twelve years old between the time the sample was chosen and the time of the interview were also excluded. (There were 72 such children in the entire Cycle II sample.)

[34]Significant race differences were found for the variables IHEIGHT, IWEIGHT, PFGHEALTH, ALLEG, and APERI.

[35]See Nerlove and Press (39) for a description of this technique.

[36]For the four health measures for which we find significant income effects, we also experimented with a specification for the income variable which allows for five discrete income effects rather than two continuous income effects. In particular, the variables FINC and HFINC were replaced with four dummy variables which distinguish between five income classes: less than $5,000; $5,000 to $6,999; $7,000 to $9,999; $10,000 to $14,999; and $15,000 and above. We do not show the results of this specification because it yields only one additional insight: for the highest income class income never has a significant marginal impact on health, while it does for one or more of the lower income classes. The coefficient estimates for the other explanatory variables are not sensitive to changes in the specification of the income variable.

[37]One might predict that mother's education would be more important in explaining variations in children's health than is father's education since most child care is done by the mother. We do not consistently observe this

in our results. One reason might be the high correlation between mother's and father's education (r = .67 in mother-father families).

[38]These estimates "maximize" the effect of not having a father in the sense that they are derived under the extreme assumption that father's education has the same relationship with child health whether or not the father is actually present (and that the average educational attainment of absent fathers is the same as for fathers living with their families). These assumptions are needed to obtain estimates of the relationship between NOFATH and the various health measures because there is no information in our data on the educational attainment of fathers who do not currently live with their children. Use of the alternative extreme assumption, that there is no relationship between father's education and child health for children whose fathers are absent from the home, generates "minimum" estimates of the effect of having an absent father. These "minimum" estimates also indicate that NOFATH has both positive and negative relationships with better health, depending on the health measure used: significant positive health relationships with NOFATH are reported for PFGHEALTH, HDBP, and APERI; and a significant negative relationship is reported for SCHABS.

[39]This lack of significance is especially notable because the endogenous nature of the mother's work status variables biases their coefficients towards having a larger negative relationship with child health than they would have simply as measures of the mother's opportunity cost of time.

REFERENCES

1. Landes, William M., and Solmon, Lewis C. "Compulsory Schooling Legislation: An Economic Analysis of Law and Social Change in the Nineteenth Century." Journal of Economic History, 32, No. 1 (March 1972).

2. Averch, Harvey A., et al. How Effective is Schooling? A Critical Review and Synthesis of Research Findings. Santa Monica: The Rand Corporation, 1972.

3. Keniston, Kenneth, and the Carnegie Council on Children. All Our Children: The American Family Under Pressure. New York: Harcourt Brace Jovanovich, 1977.

4. Foltz, Anne-Marie, and Brown, Donna. "State Response to Federal Policy: Children, EPSDT, and the Medicaid Muddle." Medical Care, 13, No. 8 (August 1975).

5. Haggerty, Robert J., et al. Child Health and the Community. New York: John Wiley and Sons, 1975.

6. Starfield, Barbara. "Health Needs of Children." In Children's Medical Care Needs and Treatment. Harvard Child Health Project Report, Volume II. Cambridge, Mass.: Ballinger Publishing Co., 1977.

7. Kaplan, Robert S., et al. "The Efficacy of a Comprehensive Health Care Project: An Empirical Analysis." American Journal of Public Health, 62, No. 7 (July 1972).

8. Hu, Teh-Wei. "Effectiveness of Child Health and Welfare Programs: A Simultaneous Equations Approach." Socio-Economic Planning Sciences, 7 (1973).

9. Kessner, David M. Assessment of Medical Care for Children. Contrasts in Health Status, Vol. 3. Washington, D.C.: Institute of Medicine, 1974.

10. Inman, Robert P. "The Family Provision of Childrens Health: An Economic Analysis." In The Role of Health Insurance in the Health Services Sector, edited by Richard Rosett. New York: Neal Watson Academic Publications for the National Bureau of Economic Research, 1976.

11. National Center for Health Statistics. Examination and Health History Findings Among Children and Youths, 6-17 Years. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Series 11, No. 129 (November 1973).

12. National Center for Health Statistics. Plan, Operation, and Response Results of a Program of Children's Examinations. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Series 1, No. 5 (1967).

13. U.S. Bureau of the Census, 1970 Census of Population, Vol. I, Characteristics of the Population, Part 1, U.S. Summary, Sections 1 and 2. Washington, D.C.: Government Printing Office, 1973.

14. Becker, Gary S., and Lewis, H. Gregg. "On the Interaction between the Quantity and Quality of Children." In New Economic Approaches to Fertility, edited by T.W. Schultz. Proceedings of a conference sponsored by the National Bureau of Economic Research and the Population Council. Journal of Political Economy, 81, No. 2, Part II (March/April 1973).

15. Willis, Robert. "A New Approach to the Economic Theory of Fertility Behavior." In New Economic Approaches to Fertility, edited by T.W. Schultz. Proceedings of a conference sponsored by the National Bureau of Economic Research and the Population Council. Journal of Political Economy, 81, No. 2, Part II (March/April 1973).

16. Ben-Porath, Yoram, and Welch, Finis. "Do Sex Preferences Really Matter?" The Quarterly Journal of Economics, 90, No. 2 (May 1976).

17. Edwards, Linda N., and Grossman, Michael. "An Economic Analysis of Children's Health and Intellectual Development." National Bureau of Economic Research Working Paper No. 180, May 1977.

18. Edwards, Linda N., and Grossman, Michael. "The Relationship between Children's Health and Intellectual Development." National Bureau of Economic Research Working Paper No. 213, November 1977.

19. Leibowitz, Arleen, and Friedman, Bernard. "Family Bequests and the Derived Demand for Health Inputs." Mimeo., 1976.

20. Tomes, Nigel. "Intergenerational Transfers of Human and Non-Human Capital in a Model of Quality-Quantity Interaction." Ph.D. dissertation, University of Chicago, 1978.

21. Ishikawa, Tsuneo. "Family Structures and Family Values in the Theory of Income Distribution." Journal of Political Economy, 83, No. 5 (October 1975).

22. Sullivan, Daniel F. Conceptual Problems in Developing an Index of Health. PHS Pub. No. 1000, Vital and Health Statistics Series 2, No. 17. Rockville, Md.: National Center for Health Statistics, 1966.

23. Berg, Robert L. Health Status Indexes. Proceedings of a conference conducted by Health Services Research, Tuscon, Arizona, October 1972. Chicago: Hospital Research and Educational Trust, 1973.

24. Ware, Jr., John E. "The Conceptualization and Measurement of Health for Policy Relevant Research in Medical Care Delivery." Presented at the annual meeting of the American Association for the Advancement of Science, Boston, Massachusetts, February 1976.

25. Grossman, Michael. The Demand for Health: A Theoretical and Empirical Investigation. New York: Columbia University Press for the National Bureau of Economic Research, 1972.

26. Torrance, George W. "Health Status Index Models: A Unified Mathematical View." Management Science 22, No. 9 (May 1976).

27. Schack, Elisabeth, and Starfield, Barbara. "Acute Disability in Childhood: Examination of Agreement between Various Measures." Medical Care, 11, No. 4 (July-August 1973).

28. Birch, Herbert G., and Gussow, Joan Dye. Disadvantaged Children: Health, Nutrition, and School Failure. New York: Harcourt, Brace and World, Inc., 1970.

29. Wallace, Helen M. Health Services for Mothers and Children. Philadelphia: W.B. Saunders Company, 1962.

30. Mechanic, David. "The Influence of Mothers on Their Children's Health, Attitudes and Behavior." Pediatrics, 33 (March 1964).

31. Mindlin, Rowland L., and Lobach, Katherin S., "Consistency and Change in Choice of Medical Care for Preschool Children." Pediatrics, 48 (September 1971).

32. Talbot, Nathan B., et al., editors. Behavioral Science in Pediatric Medicine. Philadelphia: W.B. Saunders Company, 1971.

33. National Center for Health Statistics. Height and Weight of Children: United States. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Series 11, No. 104 (September 1970).

34. National Center for Health Statistics. Anthropometric and Clinical Findings. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Publication No. (HRA) 75-1229 (April 1975).

35. Seoane, Nicole, and Latham, Michael C. "National Anthropometry in the Identification of Malnutrition in Childhood." Journal of Tropical Pediatric and Environmental Child Health (September 1971).

36. National Center for Health Statistics. Hearing Levels of Children by Age and Sex: United States. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Series 11, No. 102 (February 1970).

37. National Center for Health Statistics. Binocular Visual Acuity of Children: Demographic and Socioeconomic Characteristics. U.S. Department of Health, Education and Welfare, Public Health Service, Vital and Health Statistics, Series 11, No. 112 (February 1972).

38. Russell, A.L. "A System of Classification and Scoring for Prevalence Surveys of Peridontal Disease." Journal of Dental Research, 35 (June 1956).

39. Nerlove, Marc, and Press, S. James. "Notes on the Log-Linear or Logistic Model for the Analysis of Qualitative Socioeconomic Data." Santa Monica: The Rand Corporation, 1973.

40. Lewit, Eugene M. "Experience with Pregnancy: The Demand for Prenatal Care and the Production of Surviving Infants." Ph.D. dissertation, City University of New York, 1977.

41. Auster, Richard, et al. "The Production of Health: An Exploratory Study." Journal of Human Resources, 4, No. 4 (Fall 1969).

42. Grossman, Michael. "The Correlation Between Health and Schooling." In Household Production and Consumption, edited by Nestor E. Terleckyj. New York: Columbia University Press for the National Bureau of Economic Research, 1975.

43. Newberger, Eli, et al. "Child Health in America: Toward a Rational Public Policy." Milbank Memorial Fund Quarterly 54, No. 3 (Summer 1976).

44. Marmor, Theodore R. "Rethinking National Health Insurance." The Public Interest, No. 46 (Winter 1977).

45. Colle, Ann D., and Grossman, Michael. "Determinants of Pediatric Care Utilization." National Bureau of Economic Research Working Paper No. 240, April 1978.